OROFINO CREEK PASSAGE PROJECT BIOLOGICAL AND ENGINEERING FEASIBILITY REPORT

COMPLETION REPORT 1988

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OROFINO CREEK PASSAGE PROJECT

PART I: BIOLOGICAL FEASIBILITY REPORT

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ABSTRACT

If implemented, the Orofino Creek Passage Project will provide adult fish passage at barrier waterfalls on Orofino Creek, Idaho and give anadromous salmonids access to upstream habitat. Anadromous fish are currently blocked at Orofino Falls, 8.3 km above the stream's confluence with the Clearwater River. This report summarizes results of a study to determine the potential for increasing natural production of summer steelhead (Salmo gairdneri) and spring chinook salmon (Oncorhynchus tschawytscha) in the Orofino Creek drainage by enhancing adult fish passage.

Data on fish habitat, migration barriers, stream temperatures and fish populations in the drainage were collected during 1987 and provided a basis for estimating the potential for self-sustaining anadromous salmonid production above Orofino Falls. Between 84.7 and 103.6 km of currently inaccessible streams would be available to anadromous fish following project implementation, depending on the level of passage enhancement above Orofino Falls. These streams contain habitat of poor to good quality for anadromous salmonids. Low summer flows and high water temperatures reduce habitat quality in lower mainstem Orofino Creek. Several streams in the upper watershed have habitat that is dominated by brook trout and may be poorly utilized by steelhead or salmon.

It is estimated that habitat examined above Orofino Falls is capable of producing 13,846 summer steelhead and 36,349 spring chinook salmon smolts annually. Steelhead smolt production could be realized by a self-sustaining run of fish. However, upstream passage and adult holding conditions within the Orofino Creek drainage during summer are considered likely to preclude a self-sustaining chinook salmon run.

Potential adult returns and harvests of steelhead originating above Orofino Falls after project implementation were estimated by modeling the steelhead life cycle. Depending on barrier removal activities above the falls, the project would ultimately increase annual steelhead escapements to the Clearwater River by an estimated 327 to 334 fish. Additional Orofino Creek steelhead would be harvested in downstream areas.

ACKNOWLEDGEMENTS

Clearwater BioStudies, Inc. (CBS) greatfully acknowledges the contributions of several members of SJO Engineers' project team. Mr. Charles Huntington (CBS Aquatic Biologist), Mr. Steven Eggers (CBS Fisheries Biologist) and Mr. Stephen Kucas (CBS Fisheries Biologist) were responsible for collecting and analyzing field data on stream conditions in the Orofino Creek drainage. Mr. Bryan Johnson (SJO Project Manager) and Ms. Elizabeth Thutt (SJO Environmental Engineer) helped model stream temperatures in mainstem Orofino Creek and fish passage conditions at stations within the drainage. Dr. Ted Bjornn (University of Idaho), the team's Senior Biological Advisor, toured the study area and contributed valuable insights to the feasibility study. Dr. Bjornn also provided constructive suggestions which helped improve an earlier version of this report.

CBS also wishes to acknowledge and express gratitude for the contributions several other individuals made to the project. First, a Technical Work Group provided constructive oversight and recommendations as the project progressed. Members of the group included: Mr. Bert Bowler (IDFG; Lewiston, Idaho), Mr. Al Espinosa (Clearwater National Forest; Orofino, Idaho), Mr. Bill Miller (U.S. Fish and Wildlife Service; Ahsahka, Idaho), and Mr. Pat Murphy (Nez Perce Tribe; Lapwai, Idaho). Dr. Jeff Gislason, BPA's Technical Representative, provided technical guidance during the study and helped resolve questions relating to study objectives. Ms. Carolyn Bohan, BPA's Project Manager, coordinated efforts of the Technical Work Group and kept the project moving forward.

The Burlington-Northern Railroad Co. provided valuable and unique transportation to several remote study sites along Orofino Creek. This assistance represented a deviation from their standard policy toward private ridership and was greatly appreciated.

INTRODUCTION

Within the framework of the Columbia Basin Fish and Wildlife Program, the Bonneville Power Administration (BPA) funds projects which mitigate anadromous fish losses caused by federal hydroelectric dams on the Columbia and Snake rivers. Sections 703(c)(l) and 1403.4.2 of the most recent Fish and Wildlife Program (Northwest Power Planning Council 1987) include the Orofino Creek Passage Project. If implemented by BPA, the project would provide anadromous fish passage at natural falls on Orofino Creek, a major tributary to the lower Clearwater River, Idaho. Providing passage at the falls could allow development of self-sustaining runs of anadromous salmonids in currently inaccessible streams within the Orofino Creek drainage.

The possibility of increasing anadromous salmonid production in the lower Clearwater drainage by providing access to streams above the falls on Orofino Creek has been considered for many years. In 1962, Murphy and Metsger reported that passage over the falls would provide anadromous salmonids access to approximately 100 kilometers of stream. They noted, however, that low summer flows and high water temperatures might restrict production of anadromous salmonids above the falls. More recently, U.S. Fish and Wildlife Service (USFWS) personnel made appraisal-level estimates of the steelhead production potential of the Orofino Creek drainage above Orofino Falls (Varley and Diggs 1983). Based on limited field data, Varley and Diggs suggested that the potential for steelhead production above the falls could be substantial.

In late June 1987, BPA initiated a two-phase study of the feasibility of providing anadromous fish passage at Orofino Falls and a second, unnamed falls on Orofino Creek. In Phase I, the biological feasibility of establishing self-sustaining runs of anadromous salmonids above the falls was assessed. The primary objective of Phase I was to estimate the potential for summer steelhead and spring chinook salmon production in habitat that could be made accessible above Orofino Falls. Results of the first phase project are reported here. Results of Phase II, the engineering feasibility of passing adult anadromous salmonids over the falls, will be given in a later report.

STUDY AREA

Orofino Creek is a large, fifth-order stream and one of the major tributaries of the lower Clearwater River in northwestern Idaho (Figure 1). The stream originates on the slopes of Hemlock Butte and flows approximately 70 km in a westerly direction, through primarily private lands, to its confluence with the Clearwater River at the town of Orofino (RK 72.4). The upper-most reaches of Orofino Creek and a few f its tributaries lie within the boundaries of the Clearwater National Forest. Between the town of Pierce and Orofino Falls, the stream flows through a relatively remote canyon. The lower-most 4.8 km of Orofino Creek flow through the Nez Perce Indian Reservation.

The Orofino Creek drainage covers approximately 49,500 hectares of timberland and high meadows, varying in elevation from 310 to 1845 meters. Discharge near the stream's mouth is quite variable and has been estimated to average 17.5 cms (611 cfs) in April and 1.08 cms (30 cfs) in September (Warnick 1984; Figure 2). Water fertility is relatively low, with total dissolved solids of about 50 mg/l.

Streams in the Orofino Creek drainage are influenced by a variety of historic and ongoing land-use activities including timber harvest, mining, road and railroad construction, farming, livestock grazing and municipal development. These activities have, to varying degrees, altered the condition of salmonid habitat in Orofino Creek and its tributaries. Lower reaches of Orofino Creek experience very low flows and high water temperatures during summer, partly due to land use activities farther up in the drainage. Upper reaches of the drainage tend to have more stable streamflows and cooler summer water temperatures. General descriptions of major streams within the Orofino Creek drainage have been given by Johnson (1985).

Anadromous fish use of the drainage is currently restricted to habitat below Orofino Falls at SK 8.3 on Orofino Creek. At the falls, water drops 25.3 vertical meters over a horizontal distance of 162 meters in a boulder-filled cataract (Figure 3). A second, unnamed falls (hereafter referred to as Upper

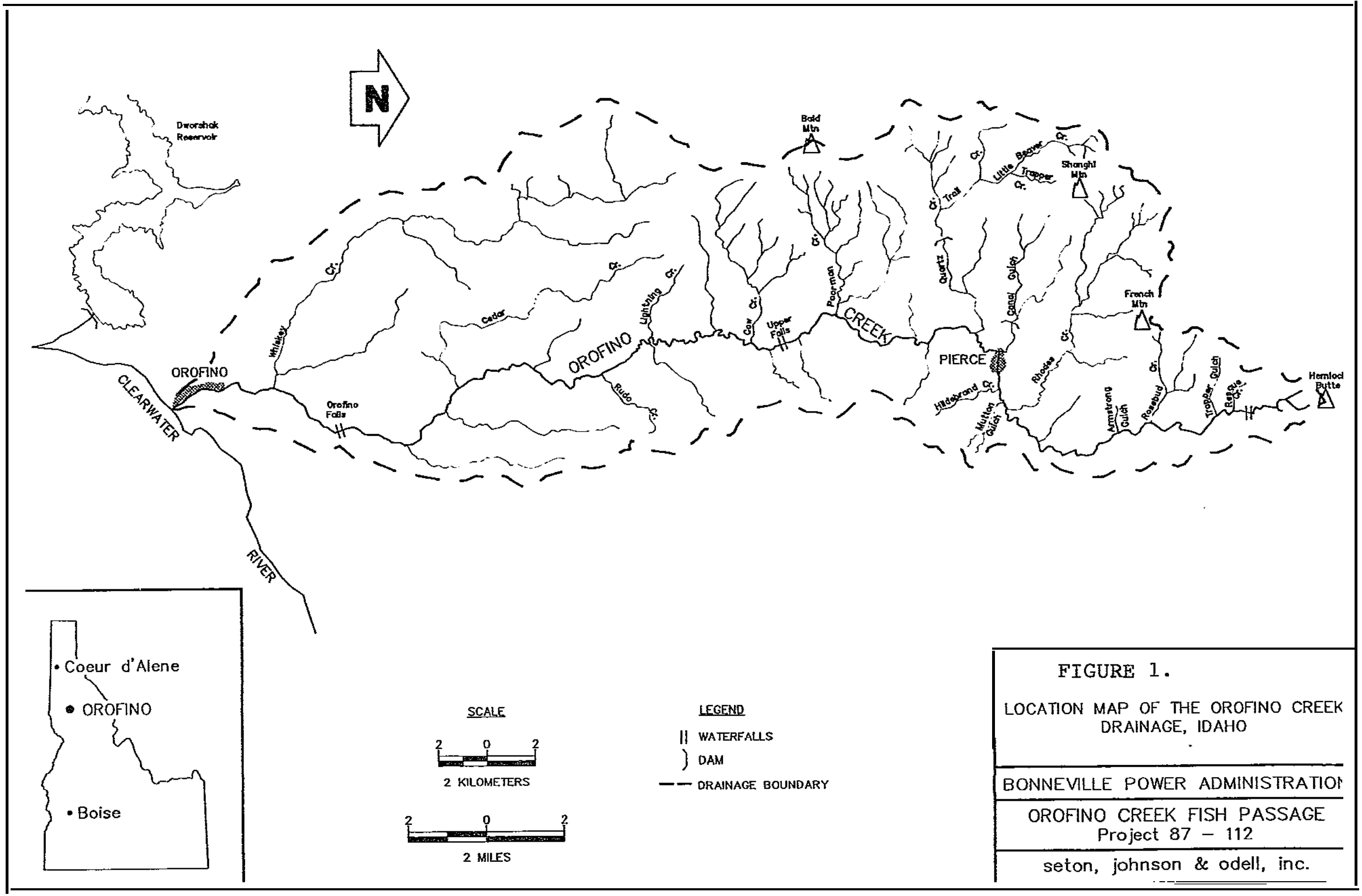

FIGURE 1.

LOCATION MAP OF THE OROFINO CREEK DRAINAGE, IDAHO

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	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
LONG–TERM AVERAGE FLOW	48	71	143	95	547	500	619	475	261	92	41	38
CRITICAL LOW FLOW	40	56	104	61	322	358	560	369	122	52	30	28

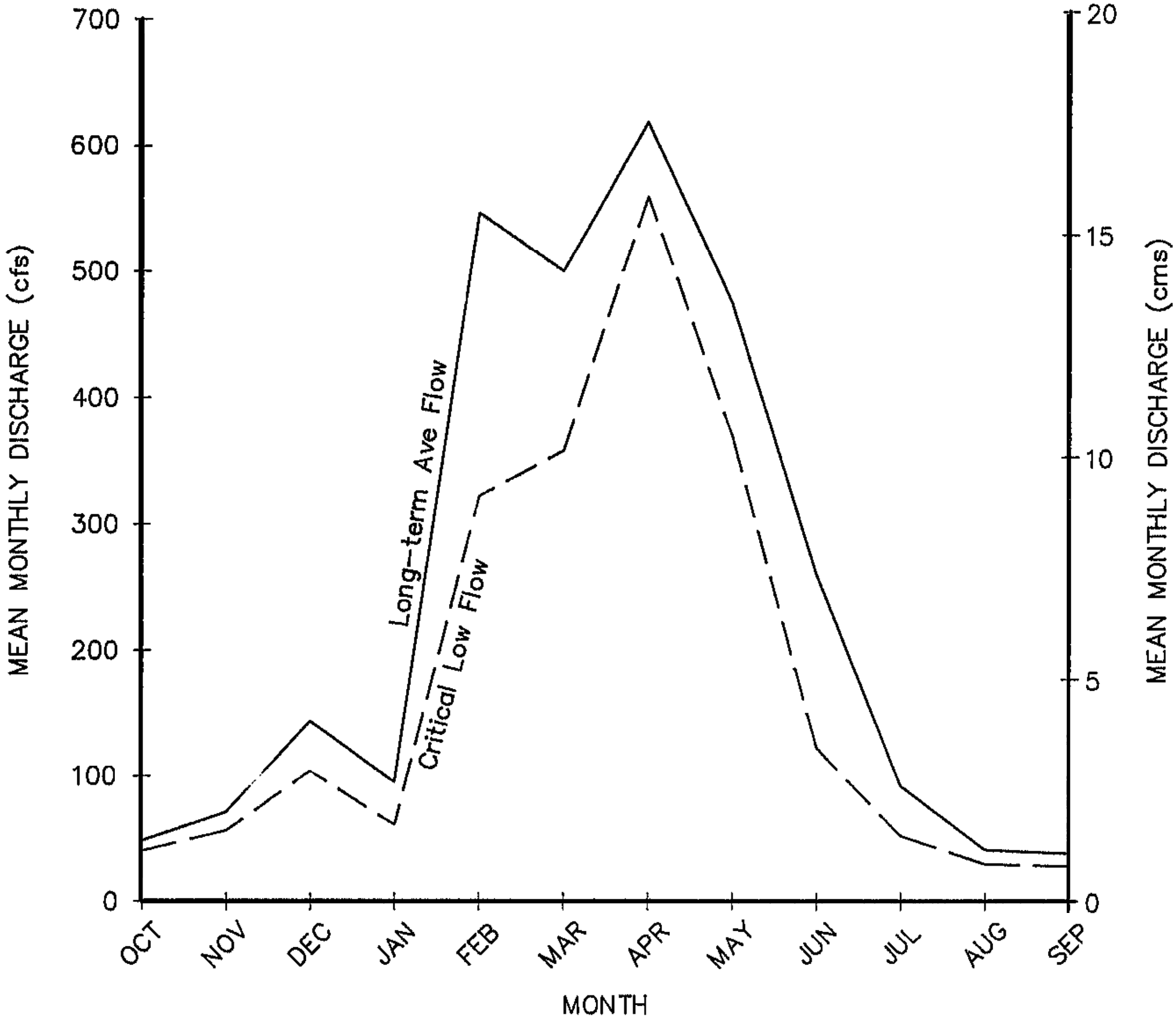

Figure 2. Estimated mean monthly discharges for long–term average, and for critcal low flow conditions at Orofino Falls (source: Warnick, 1984).

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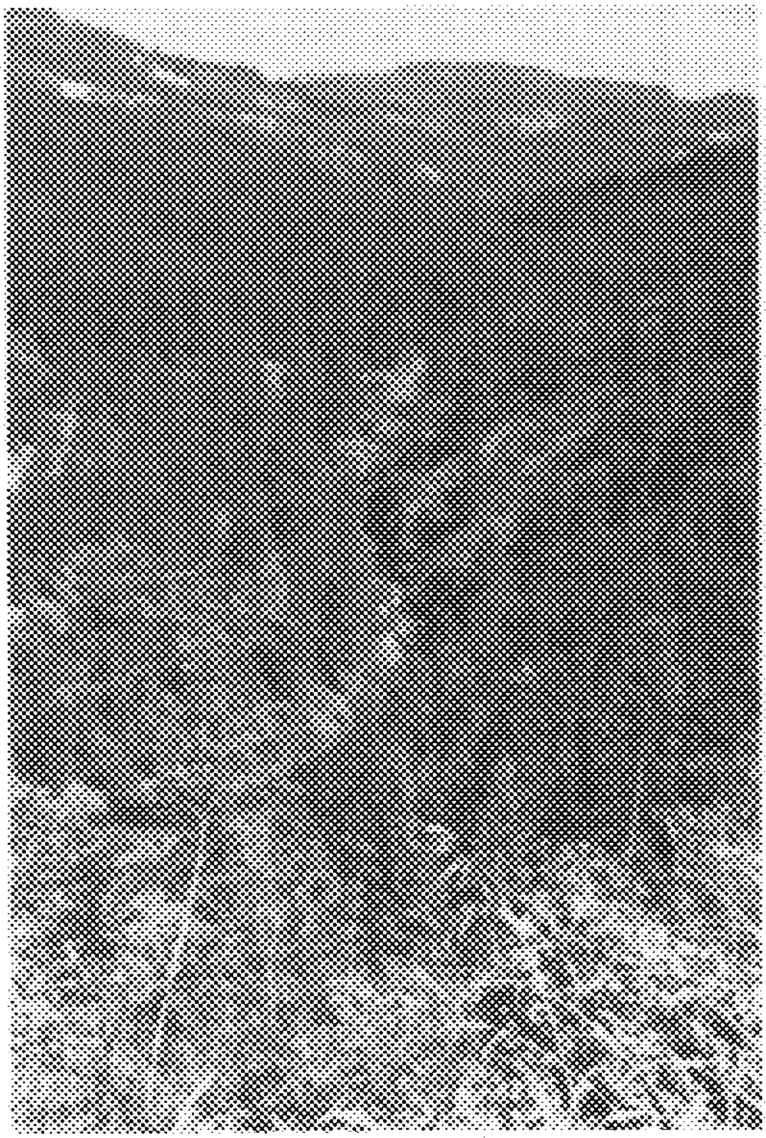

Figure 3. Photo of Orofino Falls.

Falls) at SK 32.9 on Orofino Creek has approximately 4 meters of drop and also appears to be a barrier to upstream migration (Figure 4). Habitat below Orofino Falls is used by summer steelhead but apparently unused by spring chinook salmon (Varley and Diggs 1983). Fish passage would have to be provided at both falls if upper areas of the Orofino Creek drainage were to support self-sustaining runs of either species.

METHODS

STRATA BREAKDOWN

Orofino Creek and its tributaries above Orofino Falls were divided into seven preliminary strata based upon work by previous investigators (Varley and Diggs 1983; Johnson 1985) and our reconnaissance of the study area. Each stratum was a group of streams or a section of Orofino Creek with similar fish habitat characteristics. Following an extensive stream inventory, the boundaries of the preliminary strata were narrowed to include only fish habitat that might become accessible to anadromous salmonids after passage enhancement. The final study strata provided a logical basis for analyses of habitat conditions, fish populations and the potential for anadromous salmonid production within potentially accessible areas of the Orofino Creek drainage (Table 1; Figure 5).

STREAM INVENTORY

Streams within the seven preliminary strata were broken into reaches bounded by major tributary junctions, landmarks or migration barriers. All fish habitat within each reach that would become accessible to anadromous salmonids as a consequence of passage enhancement was inventoried during July and August 1987. Reaches upstream of some migration barriers lacked anadromous salmonid habitat or had far less habitat than would justify barrier modification. These reaches were examined in the field but not included in the stream inventory, and were excluded from the final study strata.

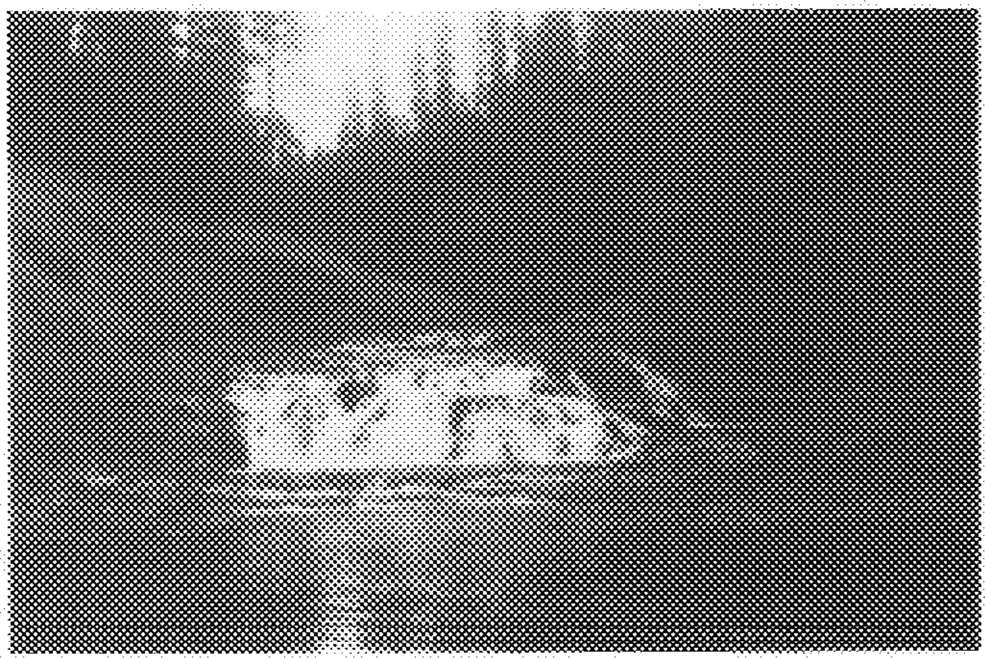

Figure 4. Photo of Upper Falls.

Table 1. Major study strata in the Orofino Creek drainage, Idaho.

Stratum	Description
1	Orofino Creek: Below Orofino Falls (SK 0.0 - 8.3)
2	Orofino Creek: Orofino Falls to Lightning Creek (SK 8.3 - 25.9)
3	Orofino Creek: Lightning Creek to Upper Falls (SK 25.9 - 32.9)
4	Orofino Creek: Upper Falls to Pierce (SK 32.9 - 46.4)
5	Orofino Creek: Above Pierce (SK 46.4 - 62.6)
6	Lower Tributaries[1]
7	Upper Tributaries[1]

1 - Reaches of streams tributary to Orofino Creek which may become accessible to anadromous fish through passage enhancement.

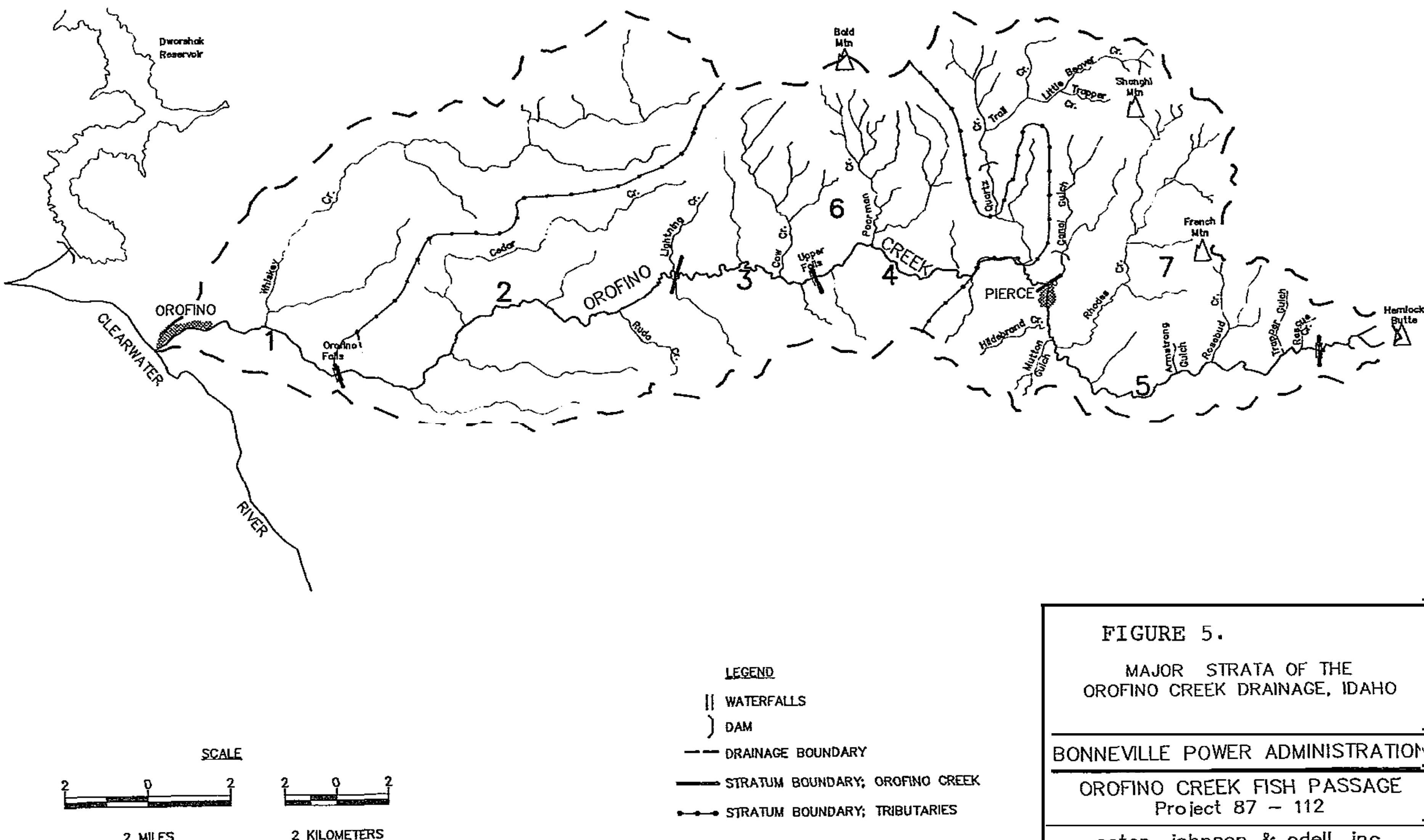

FIGURE 5.

MAJOR STRATA OF THE OROFINO CREEK DRAINAGE, IDAHO

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The entire length of each reach within the final study strata was walked to inventory available fish rearing and spawning habitat, locate potential migration barriers and adult holding pools, and assess major factors limiting salmonid production. Several important stream characteristics were carefully noted during the survey of each reach. These characteristics included channel stability, shading and bank conditions, pool quality, instream cover, substrate composition, cobble embeddedness and sediment sources, quality of available spawning habitat, availability of overwintering habitat, and the suitability of existing habitat for summer steelhead or spring chinook. Mean values for five habitat quality parameters were visually estimated for each reach (Table 2). These values were later weighted by the surface area of reaches to calculate the average parameter values for study strata.

Available rearing habitat in each stream reach was quantified using a modification of the transect method of Irving et al. (1983). Proceeding upstream, visual transects were established perpendicular to streamflow every tenth pace. Fish rearing habitat intersected by each transect was classified as: 1)pool (excluding ponds); 2) pond (pools created by beavers or historic dredge mining; 3) riffle; 4) run; 5) pocketwater; 6) glide; 7) sidechannel; or 8) backwater. Major habitat-types were identified as deep, slow water areas (pools and ponds), fast shallow areas with surface turbulence (riffles), slow shallow areas without surface turbulence (glides), areas of intermediate depth and high velocities (runs), and riffles or runs interspersed with small pools (pocketwaters). Associated habitat-types were those areas situated off the main stream and out of the current (backwaters), and channels containing less than 25 percent of streamflow (sidechannels). The wetted width of each habitat-type intersected by a transect was estimated to the nearest 0.3 meters (1 foot) and the mean depth of each estimated to the nearest 3 centimeters (0.1 foot). At every fifth transect, estimated habitat widths were cross-checked with an optical rangefinder as a means of correcting any observer bias.

The surface area of each habitat-type in a stream reach was calculated as the product of the transect spacing (actual distance covered by ten paces) and the sum of the widths estimated for that habitat-type at all transects within the reach. The volume of a given habitat-type was calculated by multiplying the

Table 2. Habitat quality parameters quantified for individual stream reaches within seven study strata of the Orofino Creek drainage, Idaho.

Habitat Parameter	Data Collected
Percent Stream Shading	estimate of reach-wide midday value
Percent Overhanging Vegetation	reach-wide visual estimate of the stream area with overhanging vegetation one meter or less above the water surface
Pool Quality	estimated mean value for pools in reach using Platts et al.'s (1983) scale of 1 (poor) to 5 (excellent)
Riffle Substrate Composition	reach-wide visual estimate of mean percentage of riffle substrate in each of six particle size classes: bedrock boulders 0305 mm dia.) rubble (152.2-305 mm dia.) cobble (76.1-152.2 mm dia.) gravel (4.71-76.1 mm dia.) fine sediment (<4.71 mm dia.)
Percent Cobble Embeddedness	reach-wide visual estimate of the degree to which cobble surfaces in riffles are covered with fine sediment

transect spacing by the sum of the cross-sectional areas of that habitat-type at all transects within the reach.

Available spawning habitat for summer steelhead and spring chinook was identified during the stream inventory using criteria established by Espinosa (1976). The length and width of each potential spawning area were measured to the nearest 0.3 meters using an optical rangefinder and recorded along with the area's location within a specific reach.

Holding pools for adult spring chinook were classified on the basis of their size, volume, depth and cover. Large pools with depths of at least 1.5 meters and some form of cover for resting fish were considered structurally suitable as adult holding habitat. Water temperature was not a criterion used to classify holding pools. The location, length, width and estimated mean depth of each suitable holding pool within each reach was recorded during the inventory.

The location, type and height of each structural barrier to fish migration encountered during the stream inventory were also recorded. The severity of each individual barrier was assessed subjectively based on the difficulties it would present to migrating summer steelhead and spring chinook.

STREAM TEMPERATURES

Stream temperatures were monitored during July and August 1987 at 12 stations within the Orofino Creek drainage (Figure 6). Continuously recording thermographs were installed at five stations, four of them on mainstem Orofino Creek. Submersed maximum-minimum thermometers were checked and reset weekly at the seven other stations.

Collected temperature data were used to assess limitations that high water temperatures may place on future anadromous salmonid production in the Orofino Creek drainage. Particular emphasis was placed on mainstem Orofino Creek

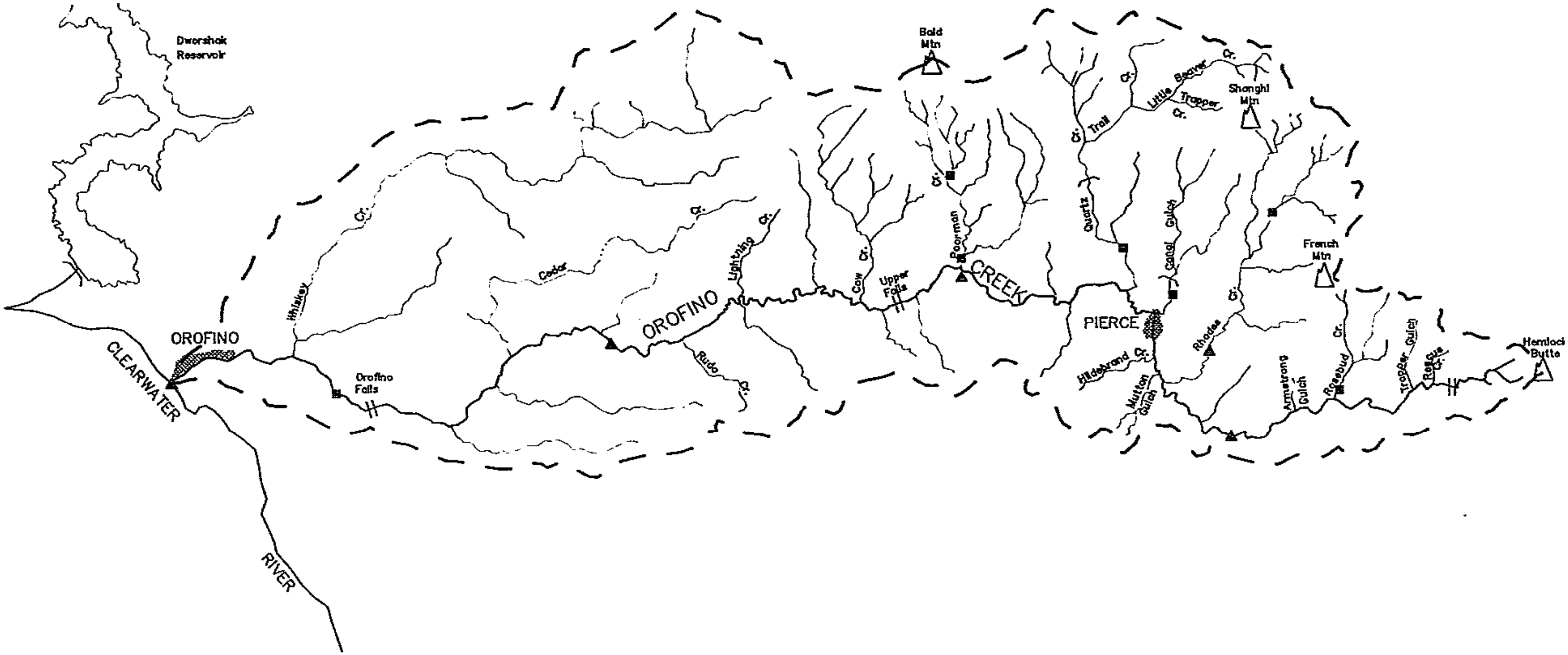

FIGURE 6.

TEMPERATURE MONITORING STATIONS IN STREAMS OF THE OROFINO CREEK DRAINAGE, 1987

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because it contains much of the drainage's habitat for anadromous fish and had been reported to experience relatively high water temperatures during the summer months.

Low streamflows observed in the Orofino Creek drainage during 1987 raised the possibility that stream temperatures recorded during our study might have been abnormally high. For this reason, the Environmental Protection Agency's QUAL2E stream model (Linfield and Barnwell 1985) was used to simulate typical summer water temperatures for the longitudinal profile of Orofino Creek. Model inputs included meteorological conditions, streamflow, channel geometry and roughness, stream slope, aspect, mean basin elevation, solar radiation, and day length. QUAL2E was first calibrated to Orofino Creek conditions using water temperature and stream channel data collected during this study and meteorological data collected by the U.S. Weather Bureau at Lewiston, Idaho during July and August 1987. The model was then used to predict Orofino Creek temperatures under typical summer conditions, based on estimated long-term average streamflows (Warnick 1984) and historic meteorological conditions (PNWRBC 1969; R. Steadham, U.S. Weather Service, pers comm.).

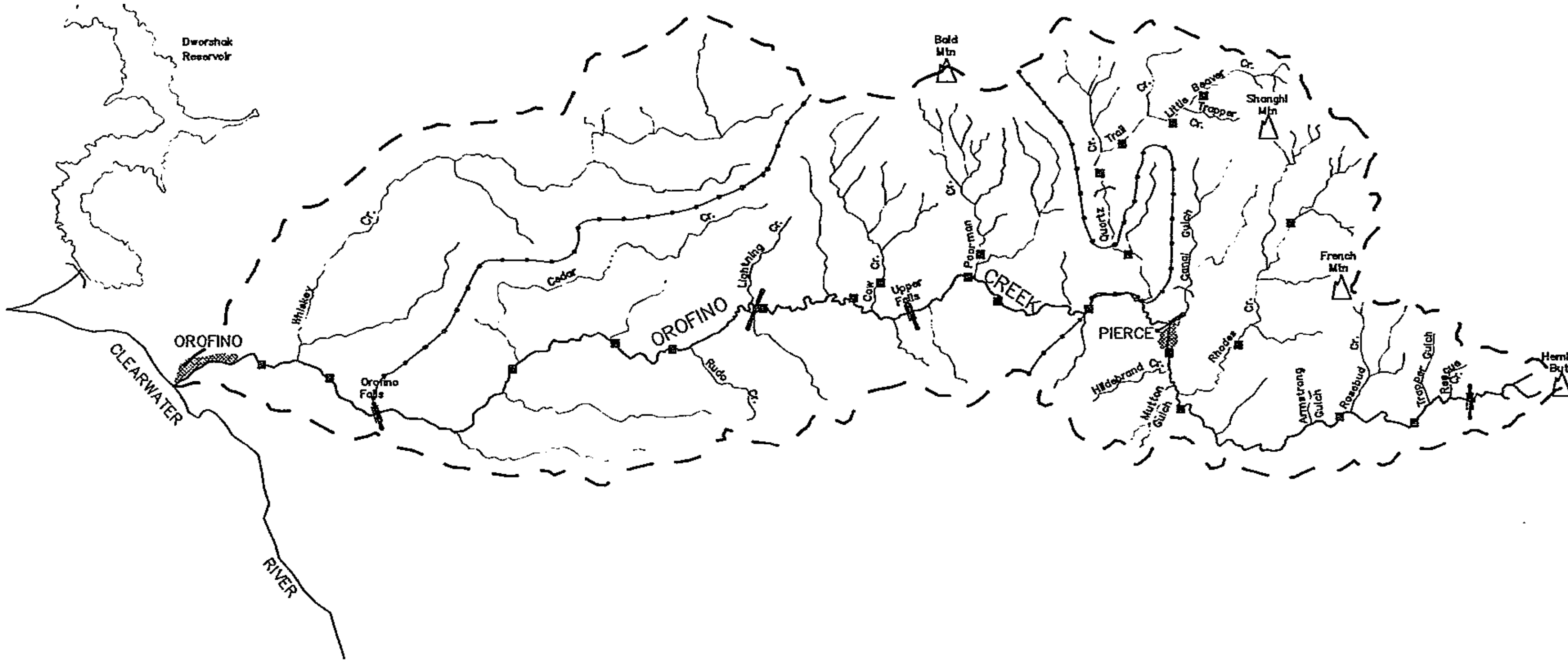
RESIDENT FISH POPULATIONS

Existing fish populations within the Orofino Creek drainage should provide an indication of the suitability of available habitat and its potential to produce anadromous salmonids. Resident fish populations were sampled within each of the seven study strata to determine species composition, distribution and abundance. Particular attention was placed on resident trout because their habitat requirements are generally similar to those of juvenile summer steelhead and spring chinook.

Fish populations were sampled at 23 stations within the Orofino Creek drainage during August 1987 using electrofishing and snorkel-census techniques (Table 3; Figure 7). Stations were selected to provide a wide geographic distribution within each of the seven study strata and to be representative of habitat conditions observed within each stratum during the habitat inventory. Each

Table 3. Fish sampling stations within seven strata of streams in the Orofino Creek drainage, 1987.

Stratum/Station	Elevation (m)
1. Orofino Creek Below Orofino Falls	
Orofino Creek Near Konkolville (SK 3.8)	355
Orofino Creek Below Orofino Falls (SK 6.9)	380
2. Orofino Creek (Orofino Falls-Lightning Creek)	
Orofino Creek Near Cedar Creek (SK 15.1)	535
Orofino Creek Near Lime Mountain (SK 18.9)	565
Orofino Creek at Rudo (SK 22.1)	605
3. Orofino Creek (Lightning Creek-Upper Falls)	
Orofino Creek Near Lightning Creek (SK 26.1)	670
Orofino Creek Below Cow Creek (SK 31.2)	740
4. Orofino Creek (Upper Falls-Pierce)	
Orofino Creek at Poorman (SK 36.4)	820
Orofino Creek Above Poorman (SK 37.5)	830
Orofino Creek Above Flat Creek (SK 42.6)	900
5. Orofino Creek Above Pierce	
Orofino Creek Near Pierce (SK 47.3)	940
Orofino Creek Near Cardiff (SK 50.2)	950
Orofino Creek Below Rosebud Creek (SK 56.5)	1055
Orofino Creek Near Tributary C (SK 60.2)	1145
6. Lower Tributaries	
Lower Cow Creek (SK 1.3)	775
Lower Poorman Creek (SK 0.8)	830
Quartz Creek near Threemile Creek (SK 1.9)	955
7. Upper Tributaries	
Quartz Creek below Trail Creek (SK 5.8)	990
Trail Creek below Little Beaver Creek (SK 1.6)	1005
Little Beaver Creek below Trapper Creek (SK 1.0)	1035
Little Beaver Creek above Trapper Creek (SK 2.0)	1065
Lower Rhodes Creek (SK 2.0)	960
Upper Rhodes Creek (SK 9.2)	1050



LEGEND

- WATERFALLS
- DAM
- DRAINAGE BOUNDARY
- FISH SAMPLING STATION
- STRATUM BOUNDARY; OROFINO CREEK
- STRATUM BOUNDARY; TRIBUTARIES

SCALE

2 0 2 — 2 MILES

2 0 2 — 2 KILOMETERS

FIGURE 7.

FISH SAMPLING STATIONS WITHIN SEVEN STRATA OF STREAMS IN THE OROFINO CREEK DRAINAGE, 1987

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station consisted of a cluster of separate habitat units (eg. pools, riffles, runs, etc.) which were sampled individually. A minimum of two stations were established in each of the seven strata, to allow effective subsampling of the habitat types within each stratum.

Fish in small habitat units were sampled using backpack electrofishing gear and block nets. Rainbow and brook trout in each unit were captured using standard multiple-pass removal techniques (Platts et al 1983). Successive passes were made with the electrofisher until the number of fish in each identifiable age/size group of trout captured was 50 percent or less of the number captured during the previous pass. Numbers, fork lengths, and frequently weights of rainbow and brook trout captured on each pass were recorded before any fish were returned to the stream. Scale samples were collected and analyzed to confirm age groups or assess fish growth rates. The total number of each age/size group of trout in a habitat unit was estimated using the maximum-likelyhood formula of Platts et al. (1983).

Fish in habitat units too large, deep or complex to be effectively sampled with backpack electrofishing gear were sampled using standard snorkel-census techniques (Griffith 1981; Northcote and Wilkie 1963). One or two divers conducted each census, depending on the size and complexity of the unit. Within a given habitat unit, the diver(s) snorkeled slowly upstream, counting numbers of salmonids by species and age/size group. Units were snorkeled at least twice when diver confidence in census results was not high. Information on the abundance of fish within the unit was recorded after census completion, along with information on habitat-type, predominant substrate and pool feature (eg. debris, meanders, bedrock, etc.).

The surface area and volume of each habitat unit sampled by electrofishing or snorkeling was measured using transect methods described by Platts et al (1983). Numerical densities of trout in individual habitat units were calculated by dividing the numerical abundances estimated from electrofishing or snorkel-census data by the surface area of the unit.

Populations and the average numerical densities of trout in the seven stream strata were estimated from their abundance in representative units of the habitat-types within each stratum. The number of trout in a given stratum was calculated as:

$$T = \sum_{i=1}^{n} (A(i))(N(i)),$$

where,

T = total number of a given species age-group within the stratum,

i = numeric code for a specific habitat-type,

n = total number of habitat-types within the stratum,

A(i) = total surface area of habitat-type "i" within the stratum,

N(i) = mean density (number/100 sq m) of a given species age-group within all units of habitat-type "i" sampled within the stratum.

In a few instances certain habitat-types were not sampled within a stratum due to their absence at sampling stations. In these cases mean trout densitites for the most similar habitat-type(s) within the stratum, or for the same habitat-type in the most similar of the other strata, were used when calculating population estimates.

Relative abundances of fish species at each station were rated on a qualitative scale of 1 (very few) to 5 (very abundant) at the time of sampling. Data on the relative abundances of non-salmonid species were later used to help resolve questions about their distribution within the Orofino Creek drainage, potential interspecific competition with steelhead or salmon, and about typical stream temperatures.

FACTORS AFFECTING ADULT SPRING CHINOOK

Prior to this study, it was suggested that the hydrologic regime of Orofino Creek might not be well suited to supporting a run of spring chinook salmon (BPA 1987). There were concerns that problems related to 1) low streamflows, 2) high water temperatures or 3) poor water quality would adversely affect upstream migrations and survival of adult spring chinook. We assessed the severity of these potential problems.

Low Streamflows

Low streamflows and resultant poor passage conditions at numerous shallow riffles in Orofino Creek and its largest tributaries might impair upstream passage of adult spring chinook. Passage conditions in the riffles could at times prevent migrating fish from reaching adult holding pools or spawning areas available above Orofino Falls.

Passage transects were established at five shallow riffles typical of those found throughout the Orofino Creek drainage (Figure 8). Transect sites were selected to represent riffles which provide poor upstream passage conditions below Orofino Falls, between the falls and adult holding pools, and between holding pools and potential spawning areas for spring chinook. At each of the five sites, stream cross-section, slope and flow data were collected using a level, rod, measuring tape and Gurley meter. These data and Manning's equation were then used to model the stage-discharge relationship for each site. The minimum flow allowing passage at a given site was determined as the streamflow which just met the two following stream depth criteria (Thompson 1972):

1. water depth of 0.24 meters (0.8 feet) over at least 25 percent of the total cross-section width

2. water depth of 0.24 meters (0.8 feet) over a continuous portion equalling at least 10 percent of the total width.

Once determined, minimum passage flows for the five sites were correlated with seasonal streamflow information on Orofino Creek. Relative streamflows at the sites were related to flows at Orofino Falls using streamflow data collected at various locations within the drainage during studies by the Nez Perce Tribe (Johnson 1985) and Idaho Department of Health and Welfare (unpubl. data). Available streamflow information on Orofino Creek near Orofino Falls (Murphy 1985, 1986, pers. comm.; Warnick 1984; USGS 1983) were then examined to assess the severity of passage problems likely to develop at the five sites. This gave an indication of the degree to which future spring chinook runs might be impaired by poor passage conditions at shallow riffles.

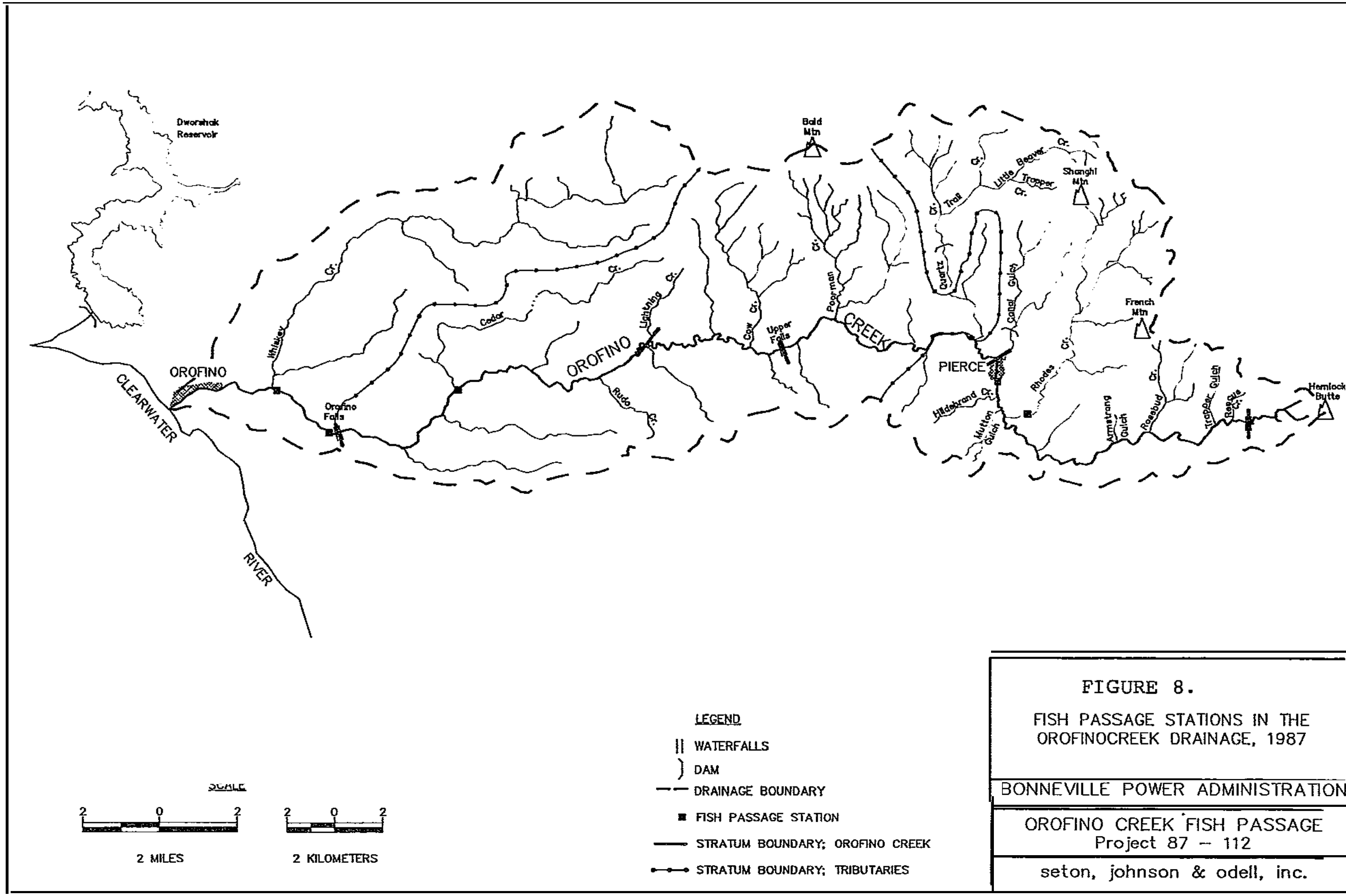

FIGURE 8.

FISH PASSAGE STATIONS IN THE OROFINOCREEK DRAINAGE, 1987

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Water Temperatures

High water temperatures in Orofino Creek may impede upstream movements of adult spring chinook or stress adult fish holding in the stream during summer. Stream temperature data collected during this and other studies were examined to assess the severity of any water temperature problems in Orofino Creek which might affect the survival and spawning success of adult spring chinook.

Water Quality

Available water quality data on Orofino Creek were examined to determine the extent of any water quality problems which might adversely affect adult spring chinook returning to spawn above Orofino Falls.

FACTORS LIMITING PRODUCTION

Factors which will limit self-sustaining production of summer steelhead and spring chinook above Orofino Falls were determined from results of the stream inventory, careful examination of water temperature and resident fish data, a review of pertinent literature, and evaluation of factors that will affect the spawning success of spring chinook. Factors which were considered include:

- low streamflows
- high water temperatures
- lack of suitable habitat
- quality of available habitat
- riparian conditions
- competition with existing fish populations
- migration barriers
- land use activities

ESTIMATES OF POTENTIAL SMOLT PRODUCTION

Field data collected during 1987 and information from other studies were used to develop estimates of potential summer steelhead and spring chinook smolt production for habitat which may become accessible through implementation of the Orofino Ceek Passage Project. Field data collected during this study provided a common basis for all estimates. The estimates were of two basic types. One type was based on the numbers of trout currently residing in potentially available habitat. The other type of estimate applied numerical densities of presmolt steelhead and spring chinook within specific habitats in accessible Idaho streams during summer to the surface areas of similar habitats in potentially accessible streams within the Orofino Creek drainage. Detailed explanations of each estimation methodology are given in the RESULTS section of this report.

FISHERY BENEFITS OF PROJECT IMPLEMENTATION

Projections of the fishery benefits of providing passage at the falls were based on our estimates of potential smolt production, probable survival rates for the stream's anadromous salmonids at various stages in their life cycles, and future adult harvest rates. Reasonable values for the survival and harvest rates were obtained through a review of the literature and discussions with knowledgeable biologists. Benefits were projected for summer steelhead or spring chinook only if it was believed a species would develop a self-sustaining run following its introduction to habitat above Orofino Falls.

RESULTS AND DISCUSSION

STREAM INVENTORY

Approximately 112 kilometers of streams within the seven study strata were surveyed during the low flow period. Habitat data were collected on a total of 63 individual stream reaches which varied in length from less than 0.1 km to 7.1 km. Summaries of the data collected on each reach are given in Appendix A (Tables A-l, A-2, and A-3).

The seven study strata contained a total of 842,680 square meters of fish habitat during summer low flow (Table 4). The six strata upstream of Orofino Falls (strata 2-7), which are currently inaccessible to anadromous salmonids, contained 738,839 square meters (87.8%) of this habitat. The quality of salmonid rearing habitat in the strata ranged from poor to good.

The composition of available rearing habitat varied amoung the seven strata (Table 5). Riffles were the predominant habitat type in mainstem Orofino Creek (strata 1-5) and its lower tributaries (Stratum 6) but pool and pond habitat predominated in the upper tributaries (Stratum 7). Riffles made up 38.8 to 60.2% of total stream area in strata l-5, 47.0% in Stratum 6, but only 17.0% in Stratum 7. Conversely, pools made up an average of 67.5% of total stream area in Stratum 7, but only 33.6% in Stratum 6 and from 7.7 to 21.2% in the five mainstem strata. The upper tributaries contain approximately 20 percent more pool habitat than is contained within the other six strata combined.

Potential spawning habitat for steelhead or spring chinook is uncommon in Orofino Creek below Orofino Falls but relatively abundant above the falls (Table 4). Spawning areas for steelhead above Orofino Falls are well distributed throughout the potentially accessible reaches of Orofino Creek and most of its tributaries. Potential spawning areas for spring chinook are less abundant than those for steelhead and found only in Orofino Creek and its two largest tributaries.

Potential holding pools for adult spring chinook within the Orofino Creek drainage are found predominantly in mainstem Orofino Creek, with a few in the largest tributary streams (Table 4). Holding pools in the mainstem are primarily associated with bedrock exposures along the streambank, while those in tributaries were created by historic dredge mining or beaver dams. Mainstem Orofino Creek above Pierce, which contains the greatest concentration of high quality spawning and rearing habitat for spring chinook, lacks adult holding pools.

Average stream shading and percent overhanging vegetation are much lower along Orofino Creek downstream of Pierce (strata l-4) than they are along the mainstem above Pierce (Stratum 5) or along the tributaries (strata 6 and 7)

Table 4. Fish habitat in seven strata of streams within the Orofino Creek drainage which might be accessible to anadromous salmonids following implementation of the Orofino Creak Passage Project.

Stream/Stratum	Length (km)	Total Area (sq m)	Pool Area[1] (sq m)	Pool Volume[1] (cu m)	Adult Holding Pools (number)	Spawning Area (sq m) Steelhead	Chinook
orofino cr.							
1. Mouth-Orofino Falls	8.3	103,841	8,046	5,666	14	105	13
2. Falls-Lightning Cr.	17.6	229,410	27,566	20,763	36	8,786	3,253
3. Lightning Cr.-Upper Falls	7.0	85,915	15,075	20,010	27	465	474
4. Upper Falls-Pierce	13.5	130,920	27,795	22,705	21	14,635	9,986
5. Above Pierce	16.2	82,676	13,543	6,458	0	11,570	7,814
Above Orofino Falls	54.3	528,921	83,979	69,936	84	35,456	21,527
6. Lower Tributaries 2							
cedar cr.	0.2	110	73	17	0	0	0
Rudo Cr.	0.1	91	18	5	0	0	0
Cow Cr.	2.8	6,271	1,740	669	0	27	0
Poorman Cr.	2.8	6,646	2,065	407	0	16	0
lower Quartz Cr.	3.1	13,447	5,039	1,772	0	3	22
	9.0	26,566	8,935	2,870	0	46	0
7. Upper Tributaries 2							
upper Quartz Cr.	14.1	43,345	26,030	15,506	8	771	409
Canal Gulch	6.0	21,964	16,903	14,544	1	119	0
Pierce Valley Cr.	0.6	5,739	5,551	7,216	0	0	0
Hildebrand Cr.	0.3	1,284	1,095	552	0	0	0
Rhodes cr.	13.1	96,428	65,440	49,990	12	828	175
Mutton Gulch	0.8	3,261	3,029	1.201	0	0	0
St. Louis Gulch	0.2	256	84	20	0	0	0
Armstrong Gulch	0.4	374	226	22	0	0	0
Rosebud Creek	2.5	7,323	4.451	1,499	0	54	0
Trapper Gulch	2.1	3,211	792	199	0	174	0
Rescue Creek	0.1	136	43	9	0	6	0
unnamed tributaries	0.1	31	17	7	0	0	0
	40.3	183,352	123,661	90,758	51	1,952	584

1 - includes ponds

2 - Habitat quantities given are for all accessible streams within each tributary drainage.

Table 5. Rearing habitat in seven strata of streams within the Orofino Creek drainage which might be accessible to anadromous salmonids following implementation of the Orofino Creek Passage Project.

Stream/Stratum	Stream Length (km)	Surface Area (square meters) Pools	Ponds	Riffles	Runs	Pocket-waters	Glides	Side-channels	Back-waters	TOTAL
Orofino Creek										
1. Below Orofino Falls	8.3	8,046	0	48,510	15,986	26,886	1,173	1,417	1,823	103,841
2. Falls-Lightning Cr.	17.6	26,869	697	138,179	21,485	25,902	5,699	7,779	2,800	229,410
3. Lightning -Upper Falls	7.0	15,075	0	45,213	6,795	11,438	2,144	4,169	1,081	85,915
4. Upper Falls-Pierce	13.5	27,795	0	50,751	11,789	25,560	10,538	2,124	2,363	130,920
5. Above Pierce	16.2	12,425	1,118	41,666	6,049	10,245	7,380	2,354	1,439	82,676
Above Orofino Falls	54.3	82,164	1,815	275,809	46,118	73,145	25,761	16,426	7,683	528,921
6. Lower Tributaries[1]										
Cedar Cr.	0.2	73	0	30	2	5	0	0	0	110
Rudo Cr.	0.1	18	0	58	15	0	0	0	0	91
Cow Cr.	2.8	1,740	0	3,328	948	205	0	25	25	6,271
Poorman Cr.	2.8	2,065	0	3,415	256	563	25	176	86	6,646
lower Quartz Cr.	3.1	5,039	0	5,588	215	1,984	84	70	468	13,448
	9.0	8,935	0	12,419	1,437	2,757	109	271	579	26,566
7. Upper Tributaries[1]										
upper Quartz Creek	14.1	19,669	6,361	7,553	1,326	310	5,948	560	1,618	43,345
Canal Gulch	6.0	10,351	6,552	2,202	431	164	1,296	527	441	21,964
Pierce Valley Cr.	0.6	0	5,551	0	0	0	188	0	0	5,739
Hildebrand Cr.	0.3	206	889	22	17	114	28	0	8	1,284
Rhodes Cr.	13.1	15,746	49,694	18,260	3,038	713	3,799	1,795	3,383	96,428
Mutton Gulch	0.8	1,220	1,809	64	17	6	53	11	81	3,261
St. Louis Gulch	0.2	84	0	36	86	0	50	0	0	256
Armstrong Gulch	0.4	226	0	86	14	0	45	3	0	374
Rosebud Cr.	2.5	2,076	2,375	992	293	416	371	680	120	7,323
Trapper Gulch	2.1	689	103	1,920	144	176	61	47	71	3,211
Rescue Cr.	0.1	43	0	68	3	15	0	4	3	136
unnamed tributaries	0.1	17	0	8	6	0	0	0	0	31
	40.3	50,327	73,334	31,211	5,375	1,914	11,839	3,627	5,725	183,352

1 - Habitat quantities given are for all accessible streams within each tributary drainage.

(Table 6). This pattern reflects the flashiness of mainstem flows downstream of Pierce and a tendency for peak streamflows there to inhibit the development of riparian vegetation near the low flow channel.

Average pool quality in the study strata ranged from fair to very good (Table 6). Pool quality was rated highest (mean=3.7) in strata 3 and 7, and lowest (mean=2.2) in strata 5 and 6.

Average cobble embeddedness in riffles generally increased with increasing distance from the mouth of Orofino Cr. and was highest (mean=44%) in upper tributaries (Stratum 7)(Table 6). Cobble embeddedness in pools was not recorded during the stream inventory, but was higher than that in riffles and followed the same general trends. Embeddedness was highest in upper portions of the drainage because historic logging and mining have contributed fine sediments to streambeds. Cobble embeddedness was relatively low in mainstem riffles downstream of Pierce (strata l-4), apparently because: 1) sediment tends to accumulate in streams farther up in the drainage; and 2) lower Orofino Creek is an efficient transporter of fine sediments.

The average size distribution of riffle substrate varied widely amoung study strata. Substrate particles larger than cobble (>15.2 cm dia.) made up over 60% of the average riffle surface in Stratum 1; over 50% in strata 3,4 and 6; less than 40% in strata 2 and 5; and less than 25% in Stratum 7 (Table 6).

Strata Descriptions

Stratum 1. Orofino Creek between the mouth and Orofino Falls (Stratum 1) has a moderate overall gradient (l.6%), a stable channel influenced by past efforts at bank protection and a moderately developed riparian zone. Stream shading is highly variable and averages 20%. Stratum 1 contains salmonid habitat that is structurally good in quality, but which experiences very high water temperatures in summer.

Table 6. Average values for habitat quality parameters quantified within seven stream strata in the Orofino creek drainage, 1987.

Stratum	Percent Shade	Percent Overhanging Vegetation	Pool Quality Rating	Percent Cobble Embeddedness	Riffle Substrate Composition (%) Bedrock	Boulders	Rubble	Cobble	Gravel	Fines
1	20	3	2.3	7	2	21	37	24	7	3
2	6	1	2.9	12	3	14	21	32	22	8
3	13	3	3.7	19	6	15	35	19	13	12
4	18	3	3.5	21	7	21	25	16	21	10
5	63	30	2.2	25	2	10	20	28	23	17
6	75	52	2.2	16	4	17	27	24	15	13
7	56	31	3.7	44	0	5	16	17	22	45

substrate sizes: bedrock; boulder (>30.5 cm dia.); rubble (15.2-30.5 cm dia.); cobble (7.6-15.2 cm dia.); gravel (0.47-7.6 cm dia.); fines (<0.47 cm dia.)

At the time of the survey, stream width averaged 12.5 m and water depth 26 cm. Fish habitat in the stratum was composed of 46.7% boulder-rubble riffles, 25.9% pocketwaters, 15.4% runs, 7.7% pools, 1.8% backwaters, 1.4% sidechannels and 1.1% glides. Good instream cover was provided by coarse substrate, surface turbulence and stream depth. The stratum lacked large woody debris. Where present, pools were associated with large boulders and bedrock structure. Pool quality in the stratum averaged 2.3 (fair). Average cobble embeddedness in riffles was low (7%). Unembedded cobble and rubble were common in the stratum, making it well suited for overwintering juvenile salmon and steelhead.

Spawning habitat for salmonids in Stratum 1 was restricted to a few small patches of gravel along the stream margins and was of fair quality. Spawning gravel in the stratum was of a size suitable for use by anadromous salmonids but not by smaller resident trout. Several shallow riffles in the stratum would block upstream migration of spring chinook during the low flow period.

Stratum 2. The reach of Orofino Creek from Orofino Falls to Lightning Creek (Stratum 2) has a low to moderate gradient (mean=1.3%), a stable channel and a sparsely vegetated riparian zone. Riparian vegetation is generally well back from the low flow channel and shades an average of only 6% of the stream. Stratum 2 contains salmonid habitat that is structurally poor to good in quality, and experiences very high water temperatures in summer.

At the time Stratum 2 was surveyed, stream width averaged 13.0 m and water depth 27 cm. The composition of available fish habitat was 60.2% cobble-gravel-rubble riffles, 11.7% pools, 11.3% pocketwaters, 9.4% runs, 3.4% sidechannels, 2.5% glides, 1.2% backwaters, and 0.3% ponds. Fair instream cover was provided by coarse substrate, surface turbulence and stream depth. The stratum lacked large woody debris. Pools were associated with bedrock structure and large boulders. Pool quality in the stratum averaged 2.9 (good). Average cobble embeddedness in riffles was low (12%). High quality overwintering habitat for juvenile salmon and steelhead was moderately abundant.

Spawning habitat suitable for anadromous salmonids was abundant and of fair to good quality in Stratum 2. The stratum lacked spawning habitat for resident trout. Shallow riffles in Stratum 2 would block upstream migration of spring chinook during the low flow period and perhaps in the spring.

Stratum 3. Orofino Creek between Lightning Creek and the Upper Falls (Stratum 3) has a moderate gradient (mean=1.5%) and a very stable, bedrock-confined channel. A sparse riparian zone combines with steep topography to shade 13% of the stream. Stratum 3 contains salmonid habitat that is structurally good to excellent in quality, but experiences high water temperatures in summer.

When Stratum 3 was surveyed, average stream width was 12.3 m and mean water depth 42 cm. Rubble-cobble riffles (52.6%) were the most common habitat-type present in the stratum, followed by pools (17.5%), pocketwaters (13.3%), sidechannels (4.9%), glides (4.9%) and backwaters (1.3%). Abundant instream cover was provided by coarse substrate, surface turbulence and stream depth. The stratum lacked large woody debris. Pools were associated with bedrock structure and boulders, and were of very good quality (mean rating = 3.7). Average cobble embeddedness in riffles was low (19%). High quality overwintering habitat for juvenile salmon and steelhead was very abundant.

Spawning habitat for anadromous salmonids is relatively uncommon in Stratum 3, but that present is of good quality. The stratum lacks spawning habitat for resident trout.

Stratum 4. Orofino Creek from the Upper Falls to Pierce (Stratum 4) has a low to moderate gradient (mean=1.2%) and a moderately stable channel that is locally affected by historic dredge mining. The stratum has a moderately developed riparian zone which contributes to a modest level of stream shading (16%). Stratum 4 contains habitat which is structurally fair to good for rearing juvenile salmonids and experiences summer water temperatures which are high but not extreme.

When surveyed, Stratum 4 had an average stream width of 9.7 m and a mean water depth of 27 cm. The composition of available fish habitat was 38.8% riffles, 21.2% pools, 19.5% pocketwaters, 9.0% runs, 8.1% glides, 1.8% backwaters and 1.6% sidechannels. Instream cover was of moderate abundance and was provided by coarse substrate, surface turbulence, stream depth and undercut banks. Pools in the stratum were associated with large boulders, bedrock structure and stream meanders. Pool quality in Stratum 4 averaged 3.5 (very good). Average cobble embeddedness in riffles was relatively low (21%). Overwintering habitat for juvenile salmon and steelhead was moderately abundant.

Stratum 4 contains abundant spawning habitat for anadromous salmonids but generally lacks deposits of gravel suitable for use by smaller resident trout. Available spawning habitat is of only fair quality because it often lacks nearby cover and is generally shallow. As well, frequent use of suction dredges within the stratum tends to deposit fine sediments in surface gravels. Several shallow riffles in Stratum 4 would block upstream migrations of spring chinook during periods of low flow.

Stratum 5. Orofino Creek above Pierce (Stratum 5) has a low to moderate gradient (mean=2.5%), a stable channel and a well developed riparian zone that provides good stream shading (63%). It contains salmonid habitat that is of good quality, and experiences summer water temperatures within the range preferred by juvenile salmonids.

At the time Stratum 5 was surveyed, stream width averaged 5.1 m and water depth 20 cm. The composition of available fish habitat was 50.4% riffles, 15.0% pools, 12.4% pocketwaters, 8.9% glides, 7.3% runs, 2.9% sidechannels, 1.7% backwaters and 1.4% beaver ponds. Abundant cover was provided by woody debris, undercut banks, overhanging vegetation and surface turbulence. Pools in the stratum were associated with woody debris, large boulders, and stream meanders, and were of fair quality (mean rating = 2.2). Average cobble embededness in riffles was 25%. Overwintering habitat for juvenile salmon and steelhead was moderately abundant.

Spawning habitat for both resident and anadromous salmonids is abundant and of good quality in Stratum 5. However, spring chinook use of this habitat would be constrained by a lack of adult holding pools and by shallow riffles that would impede movements of adult fish during summer.

Stratum 6. Stream reaches in Stratum 6 (Lower Tributaries) have moderate gradients, stable streambanks, and generally well developed riparian zones that provide good stream shading (average = 75%). Riparian vegetation overhangs an estimated 52% of the stream surfaces within the stratum.

When surveyed, reaches in Stratum 6 had an average wetted width of 3.0 m and a mean water depth of 18 cm. Fish habitat in the stratum was composed of 47.0% rubble-cobble riffles, 33.6% pools, 10.4% pocketwaters, 5.4% runs, 2.2% backwaters, 1.0 % sidechannels and 0.4% glides. Moderately abundant cover was provided by coarse substrate, surface turbulence and woody debris. Pools in the stratum were associated with boulders and large woody debris. Pool quality in Stratum 6 was fair (mean rating = 2.2). Average cobble embeddedness in riffles was low (16%). Abundance of overwintering habitat for juvenile salmon and steelhead was moderate.

Stratum 6 contains limited spawning habitat for steelhead and lacks spawning habitat for spring chinook. Low flows and resultant shallow stream depths would exclude adult chinook from the stratum during summer.

Stratum 7. Stream reaches in Stratum 7 (Upper Tributaries) have low to moderate gradients, good channel stability, and moderately developed riparian zones. Riparian vegetation provides a moderate level of stream shading (average=56%). Streams in Stratum 7 have been significantly affected by historic gold mining and logging. Overall, the stratum contains salmonid habitat that is of good quality.

At the time Stratum 7 was surveyed, available fish habitat was 40.0% beaver and dredge ponds, 27.5% pools, 17.0 % riffles, 6.5% glides, 3.1 % backwaters, 2.9% runs, 2.0 % sidechannels and 1.0 % pocketwaters. Abundant cover was provided by woody debris, undercut banks, overhanging vegetation and stream depth.

Pool-type habitat was formed primarily by beaver dams, woody debris, and historic dredge mining. Pool quality in the stratum was very good (mean rating = 3.7). Average cobble embeddedness in riffles was moderately high (44%). Available overwintering habitat for juvenile salmon and steelhead consisted of deep ponds, woody debris and undercut banks. Coarse, unembedded substrate was uncommon.

Stratum 7 contains abundant spawning habitat for resident trout and moderate amounts of spawning habitat for steelhead. The stratum contains a limited amount of spawning habitat for spring chinook, but low summer flows would restrict adult chinook use of the available habitat.

Structural Migration Barriers

Over 100 structural barriers to upstream fish migration were identified within the seven study strata during the extensive stream inventory. A listing of these barriers is given in Appendix A (Table A-3). Although generally impassable during periods of low streamflow, most of the barriers could be negotiated by adult anadromous salmonids at high flow. A minimum of 19 of the structural barriers are considered likely to affect migrations of adult steelhead or spring chinook within the seven strata (Table 7).

Many stream reaches within Stratum 7 have frequent debris jams and beaver dams. Barriers of this type were common in the upper Quartz Creek, Canal Gulch, Rhodes Creek and Rosebud Creek drainages. Taken individually, each of the jams or dams should allow adult fish passage at high flow. However, sequences of these individual obstructions may, through a cumulative effect on fish vigor, limit upstream migrations of anadromous fish even under favorable streamflow conditions. The only conclusive way to determine the significance of any cumulative effect of these barriers would be to allow anadromous fish to challenge them.

Table 7. Structural barriers which may affect anadromous fish access to habitat within seven strata of streams in the Orofino Creek drainage, Idaho.

Stream	Location (km)	Barrier Type	Height (m)	Passable at High Flow?	Remarks
Orofino Creek	8.3	FallS	25.3	no	Orofino Falls
	32.9	Falls	4.0	no	Upper Falls
	33.5	Falls	2.1	probably	Trestle Falls
	38.1	Falls	1.8	yes	woody debris/boulders
	39.3	Cascades	1.8	yes	woody debris/boulders
	52.9	Beaver Dam	1.5	yes	
	56.5	Debris Dam	2.0	probably	
	56.8	Debris Dam	1.2	yes	
	57.1	Debris Dam	1.2	yes	
	51.3	Debris Dam	1.2	yes	
	57.9	Debris Dam	3.0	no	
Quartz Creek	4.7	Log Pond/Dam	2.5	no	Jaype Mill Dam
Trail Creek	0.3	Debris Dam	0.9	yes	
	2.4	Beaver Dam	0.9	yes	
Rhodes Creek	1.7	Culvert	—	probably	peak flow barrier
	4.0-9.4	Debris Dams/Beaver Dams	0.7+	yes	very frequent
canal Gulch	1.3	Storage Reservoir/Dam	2.4	no	Duffy Dam
	1.6+	Debris Dams/Beaver Dams	0.7+	yes	very frequent
Trapper Gulch	0.4	Falls	2.1	no	woody debris/boulders

STREAM TEMPERATURES

Water temperatures recorded during summer were cooler in the upper Orofino Creek drainage than in lower Orofino Creek (Table 8). Stream temperatures generally increased with increasing stream size and decreasing elevation. Mainstem Orofino Creek warmed considerably in the canyon between Pierce and Orofino due to low flows, high air temperatures, and poor streamside shading of broad, shallow riffles.

Maximum water temperatures as high as 28.5 C were measured during July at several locations in strata 1 and 2. Water temperatures this high exceed the lethal threshold temperatures that Reiser and Bjornn (1979) have reported for salmon and steelhead. However, salmonids are apparently able to withstand periodic, short-term exposure to temperatures exceeding the lethal limits (Beschta et al. 1987). Juvenile anadromous salmonids in Idaho streams are known to do well where maximum water temperatures reach the low 20's, as long as there is significant thermal relief provided by daily temperature fluctuations (T. Bjornn, pers comm.; Hahn 1977). We could find no reports of juvenile salmon or steelhead doing well at temperatures as high as 28.5 C.

Summer water temperatures differed notably amoung the four thermograph stations on mainstem Orofino Creek (see Appendix B). At Orofino (SK 0.0; Stratum l), stream temperatures reached daily maxima of 28.5 C during extended periods of hot weather and were frequently much higher than those preferred by juvenile salmon and trout (Figure 9). Daily temperature maxima in lower Orofino Creek would have consistently exceeded 25.0 C in July and early August had it not been for abnormally frequent storms (see Appendix 8). July stream temperatures at Orofino averaged 21.0 C, with a mean daily range of 18.5 to 24.5 C. Water temperatures at Orofino were somewhat cooler in August, averaging 19.5 C within a mean daily range of 16.5 to 23.0 C.

Orofino Creek temperatures recorded at Rudo (SK 19.7; Stratum 2) were slightly cooler than those measured at Orofino. Stream temperatures at Rudo (Figure 10) reached daily maxima usually identical to those at Orofino, but dropped nightly to minima which were 1.0 to 2.5 C cooler than those at Orofino. Water

Table 8. Weekly temperature rangesr recorded by thermographs and thermomethermaneters at 12 stations in the Orofino Creek drainage, 1987.

Station	Elevation (m)	Range of Stream Temperatures (C) for Week Ending							
		7/16	7/23	7/30	8/06	8/13	8/20	8/27	9/03
Orofino Creek									
Mouth (SK 0.0)	310	16.5-28.5	14.5-24.5	18.5-28.5	15.5-25.5	16.5-27.5	14.5-23-0	15-0-23.0	16.0-24.0
Below Falls (SK 7.3)	405	-	-	19.5-28.5	14.5-26.0	14.5-26.0	13.5-23.0	13.5-23.0	13.5-24-0
Rudo (SK 19.7)	570	14.5-28.5	13.5-24.0	16.5-28.5	14.0-26.0	14.5-27.5	12.5-22.5	13.5-22.0	14.5-23.0
Poorman (SK 36.4)	825	13.5-23.5	12.5-20.0	15.5-24.0	14.0-21.5	15.0-23.0	12.5-19-0	14.0-18.5	14.5-20.0
FS Boundary (SK 53.1)	995	10.0-19.5	10.0-16.5	10.5-19.5	10.0-18.5	10.5-20.0	9.5-15.5	10.0-16.5	10.5-17.5
Tributaries									
Lower Poorman Cr. (SK 0.2)	830	-	9.5-17.0	12.0-20.5	12.5-17.5	10.5-19.0	8.0-16.0	8.5-17.0	-
Upper Poorman Cr. (SK 4.0)	975	-	10.0-17.5	13.0-19.0	13.0-18.0	13.5-18.0	10.5-15.5	10.0-16.0	12.5-17.0
Quartz Cr. (SK 1.7)	955	-	11.0-18.0	14.0-22.5	14.0-19.5	13.5-21.0	12.0-17.0	13-0-17.0	12.0-19.0
Canal Gulch (SK 1.0)	940	-	10.0-17.0	13.0-22.5	11.0-20.0	9.5-20.5	9.5-18.0	12.5-16-0	10.0-20.0
Lower Rhodes Cr. (SK 1.7)	960	13.0-24.0	12.0-19.5	15.0-24.5	13.5-21.5	14.0-23.0	11.0-19.5	13.0-19.0	13.5-20.0
Upper Rhodes Cr. (SK 9.4)	1050	-	10.0-17.0	13.5-20.5	11.0-18.5	10.5-20.0	11.0-16.0	ll.0-17.5	11.5-18.5
Rosebud Cr. (SK 0.2)	1075	-	9-0-14.5	ll.5-17.5	9.5-16.5	10.5-17.5	8.5-15.0	9.5-14.5	10.5-15.5

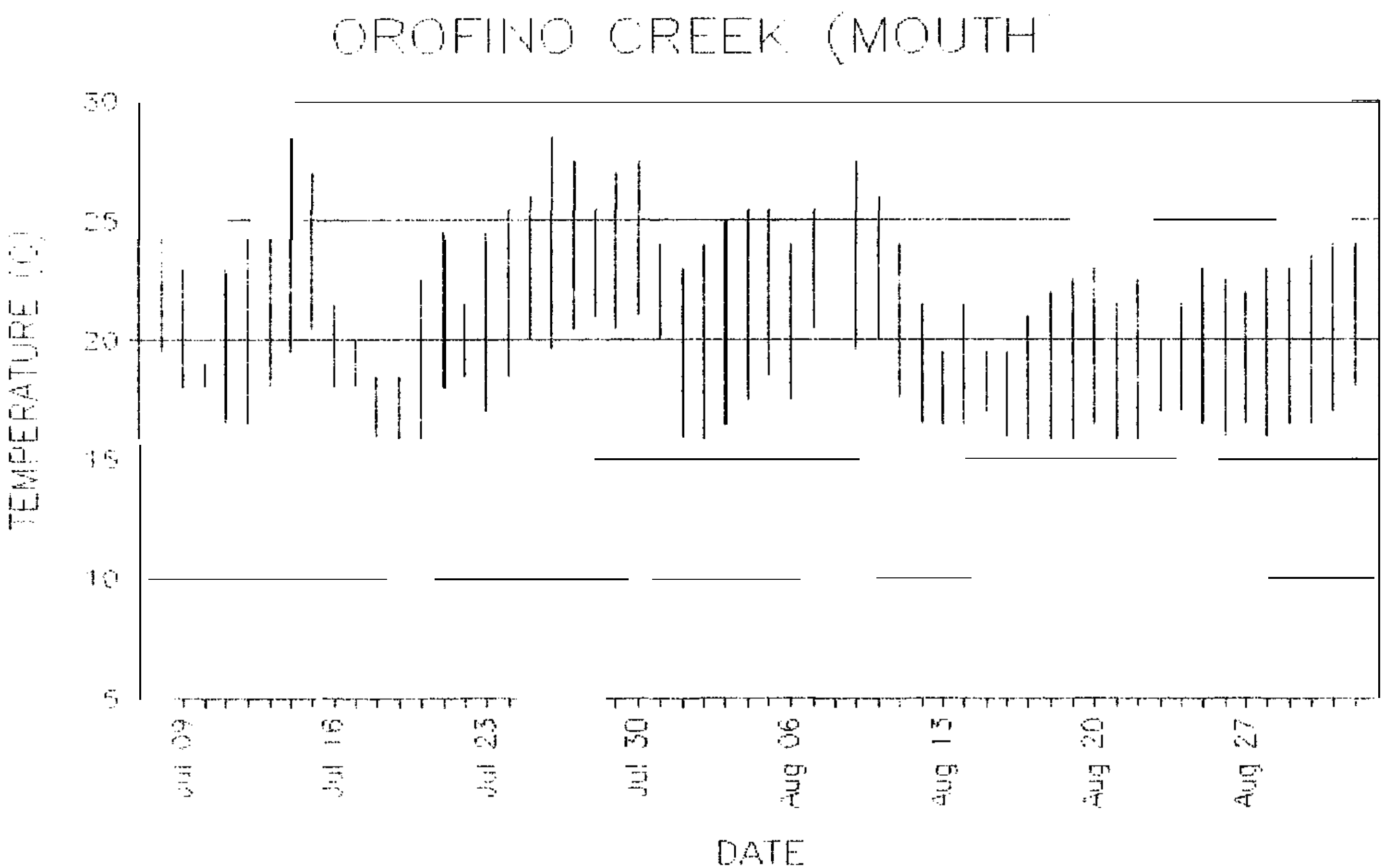

Figure 9. Daily temperature ranges recorded in Orofino Creek its mouth (SK 0.0) at Orofino, Idaho during summer 1987.

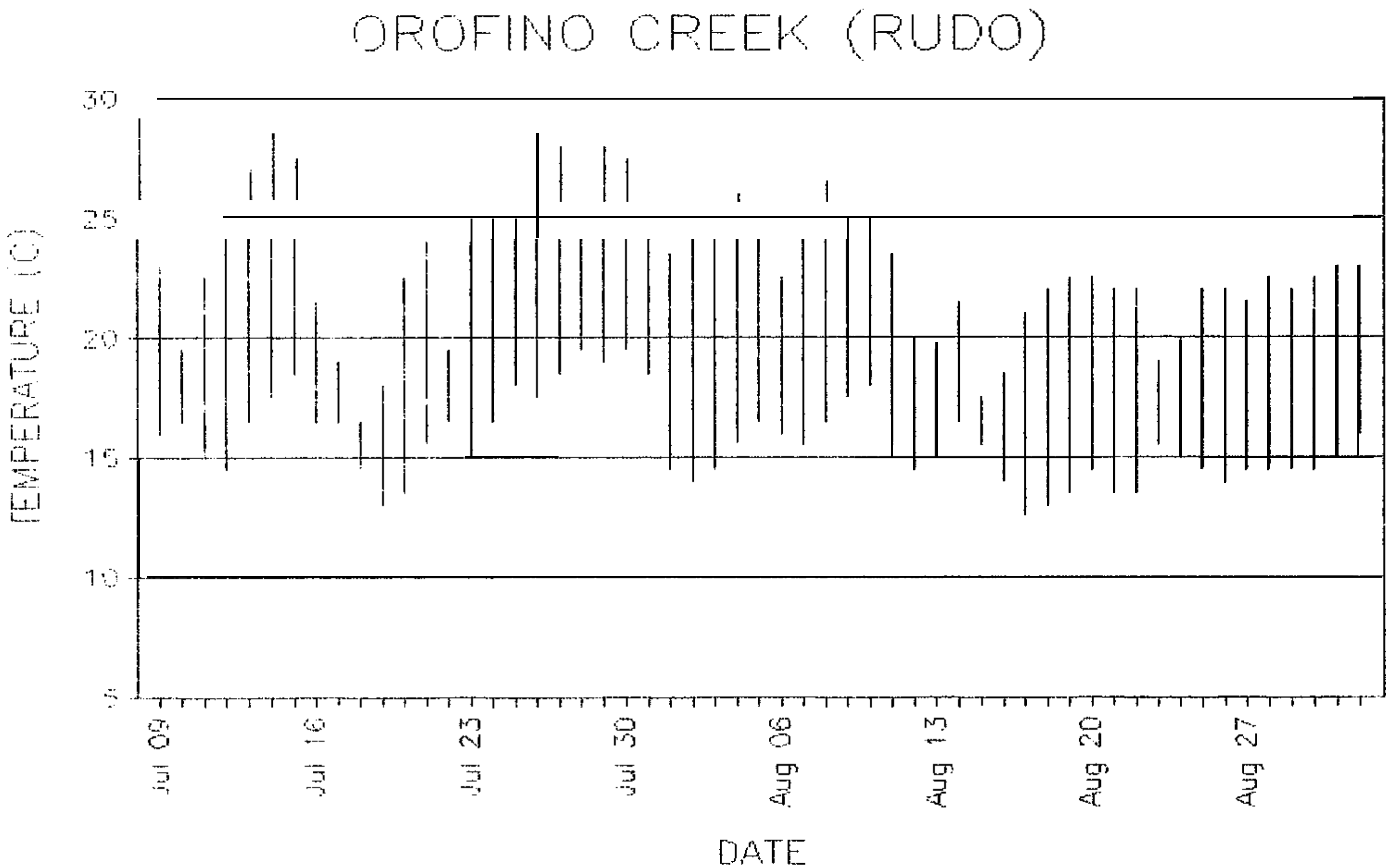

Figure 10. **Daily temperature ranges recorded in Orofino Creek at Rudo (SK 19.7), summer 1987.**

temperatures at Rudo averaged 20.0 C during July, with a mean daily range of 16.5 to 24.0 C. August temperatures at Rudo averaged 18.5 C, with a mean daily range of 15.0 to 22.5 C.

Water temperatures recorded during summer at the Poorman station (SK 36.4; Stratum 4) never exceeded 24.0 C and were more conducive to salmonid production than those measured at Rudo or Orofino. Temperatures recorded at Poorman during July and early August (Figure 11) were within the range of those which can cause disease problems, mortality, or reduced egg viability in adult spring chinook (J. Mullan, pers comm.; B. McCloud, pers comm.; B. Cates, pers comm.). Mean water temperature was 21.0 C during the week ending July 30, with a mean daily maximum of 23.0 C (Appendix B; Table B-l). Water temperatures at Poorman averaged 19.0 C during July, with a mean daily range of 16.0 to 21.0 C. In August, stream temperatures at the station averaged 17.5 C within a mean daily range of 15.0 to 19.0 C.

Summer temperatures recorded in Orofino Creek at the Forest Service boundary (SK 53.1; Stratum 5) were within the range preferred by juvenile steelhead and spring chinook (Figure 12). As well, temperatures there would not have caused major problems for adult spring chinook exposed to them during upstream migration, holding, or spawning. Water temperatures at the Forest Service boundary averaged 14.0 C in July, with a mean daily range of 11.5 to 17.0 C. Temperatures during August at the Forest Service boundary were similar to those recorded during July, averaging 14.0 C within a mean daily range of 10.5 to 16.5 C.

Stream temperatures recorded in Orofino Creek tributaries during this study should not be limiting to salmonid production. However, the temperature regimes of these streams are strongly influenced by past and present land-use within their watersheds. Maximum temperatures in Poorman and Rosebud creeks, streams that have had moderate levels of disturbance by timber harvest, rarely exceeded 19 C during July and August 1987 (Table 8). In contrast, maximum temperatures in lower Rhodes and Quartz creeks, streams subjected to major historic disturbances (timber harvest, dredge mining, road building)

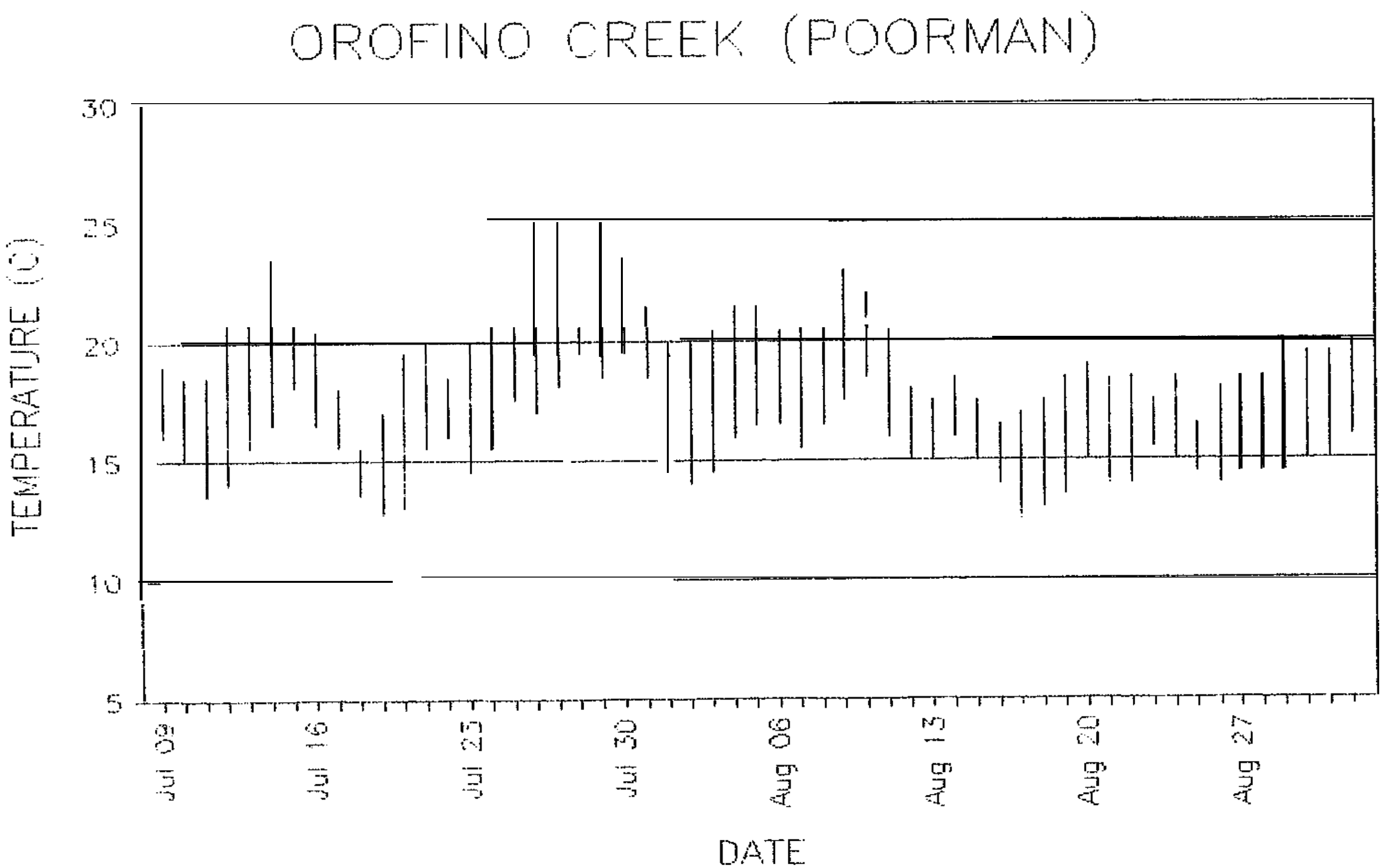

Figure 11. Daily temperature ranges recorded in Orofino at Poorman (SK 36.4), summer 1987.

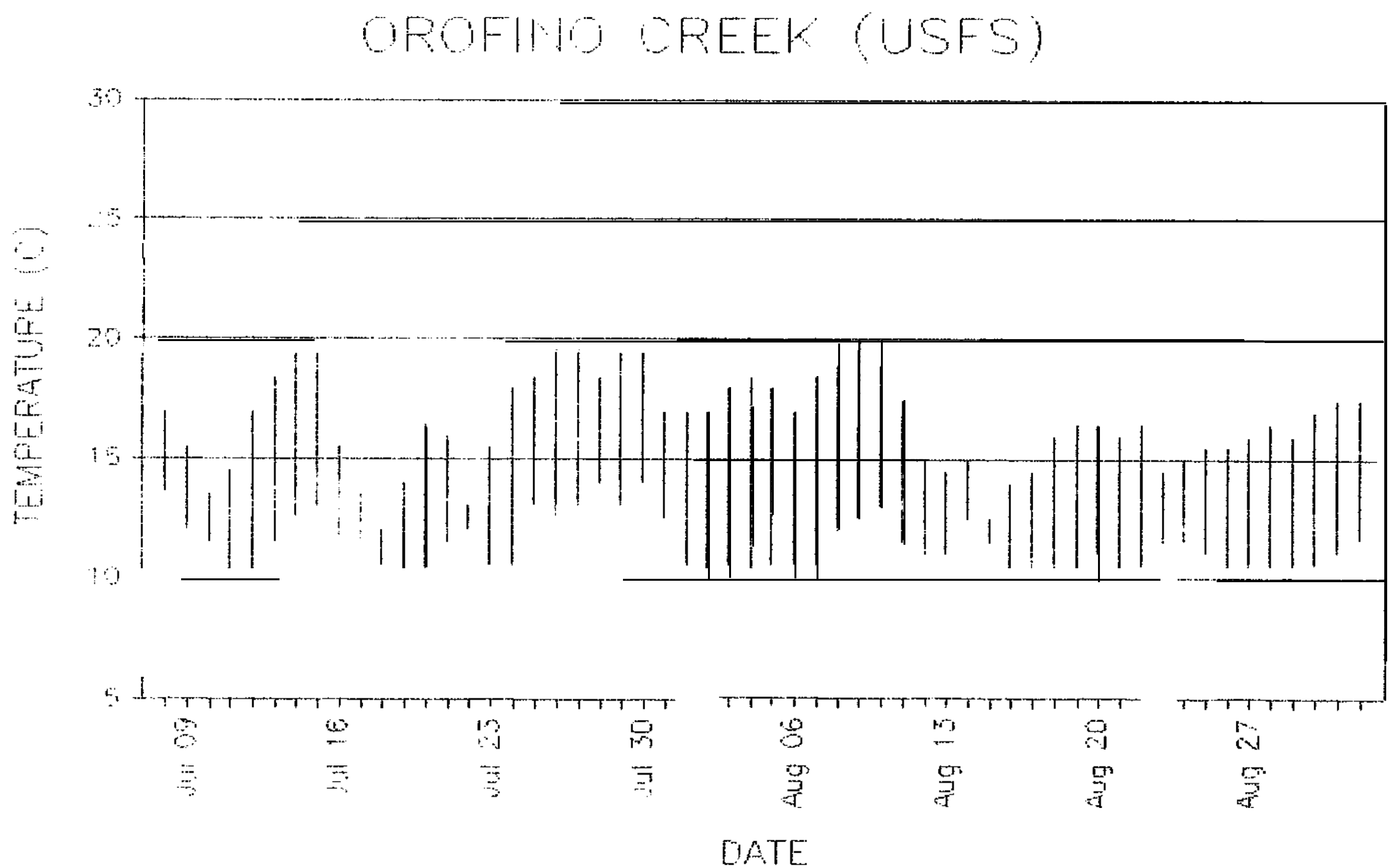

Figure 12. Daily temperature ranges recorded in Orofino Creek at the U.S. Forest Service boundary (SK 53.1), summer 1987.

frequently exceeded 20 C over the same period. During late July, water temperatures in lower Rhodes Creek briefly exceeded 24 C (Figure 13).

We calibrated QUAL2E to simulate water temperatures in Orofino Creek to within about 1 C of those measured at Orofino, Rudo, Poorman and the Forest Service Boundary during July and August 1987. QUAL2E was then used to predict water temperatures for Orofino Creek under long-term average July and August conditions. The predictions were dependent upon estimates which Warnick (1984) made of long-term average monthly flows in Orofino Creek (see Figure 2) as well as historic meteorological data collected by the U.S. Weather Bureau. Simulations of long-term average temperatures for Orofino Creek were made with two major caveats:

1. Warnick's (1984) estimates of long-term average monthly flows were extrapolated from only one year of continuous discharge data on Orofino Creek and several years of discharge data from nearby stream gauges. Average flows Warnick estimated for summer months appear, based on disjunct streamflow measurements taken on Drofino Creek over the last several years by various investigators, to be too high. Warnick's estimates of long-term average July and August flows may reflect conditions during years of moderately high or greater runoff.

2. During the study it was impossible to collect data on Orofino Creek temperatures over a wide range of known streamflows. QUAL2E was calibrated to stream temperatures measured under near-constant flows and variable weather conditions. Although QUAL2E models the effects of streamflow on temperature, we were unable to check the calibration of its temperature-flow function.

Water temperatures simulated for Orofino Creek under long-term average July conditions suggest that temperatures recorded in the stream during July 1987 were higher than average (Figure 14). Larger July streamflows than those during 1987 would tend to slow the rate at which water warms as it travels down Orofino Creek toward the confluence with Clearwater River. Differences between simulated and July 1987 temperatures were greatest for the Poorman and Rudo

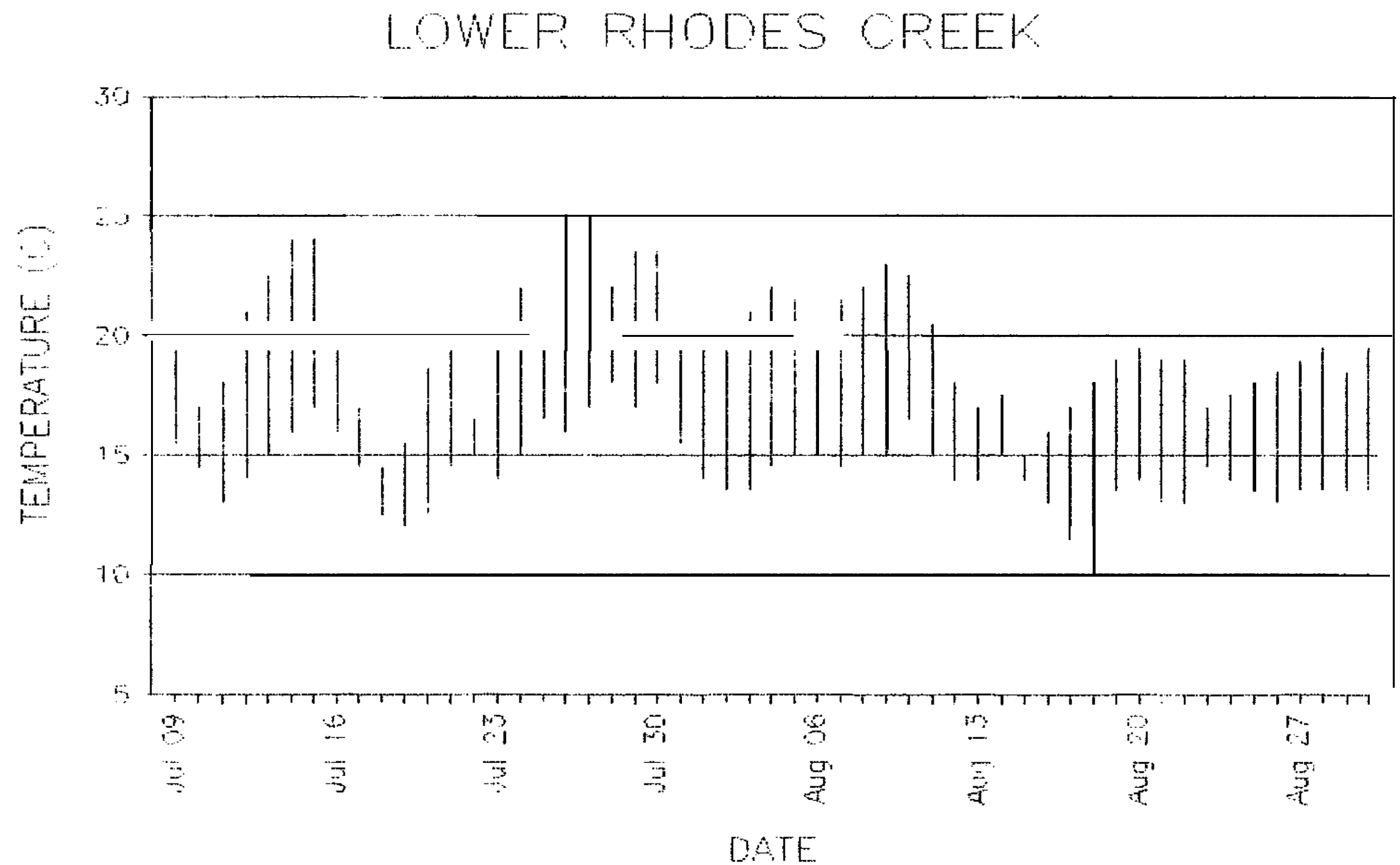

Figure 13. Daily temperature ranges recorded in lower Rhodes Creek (SK 1.7), summer 1987.

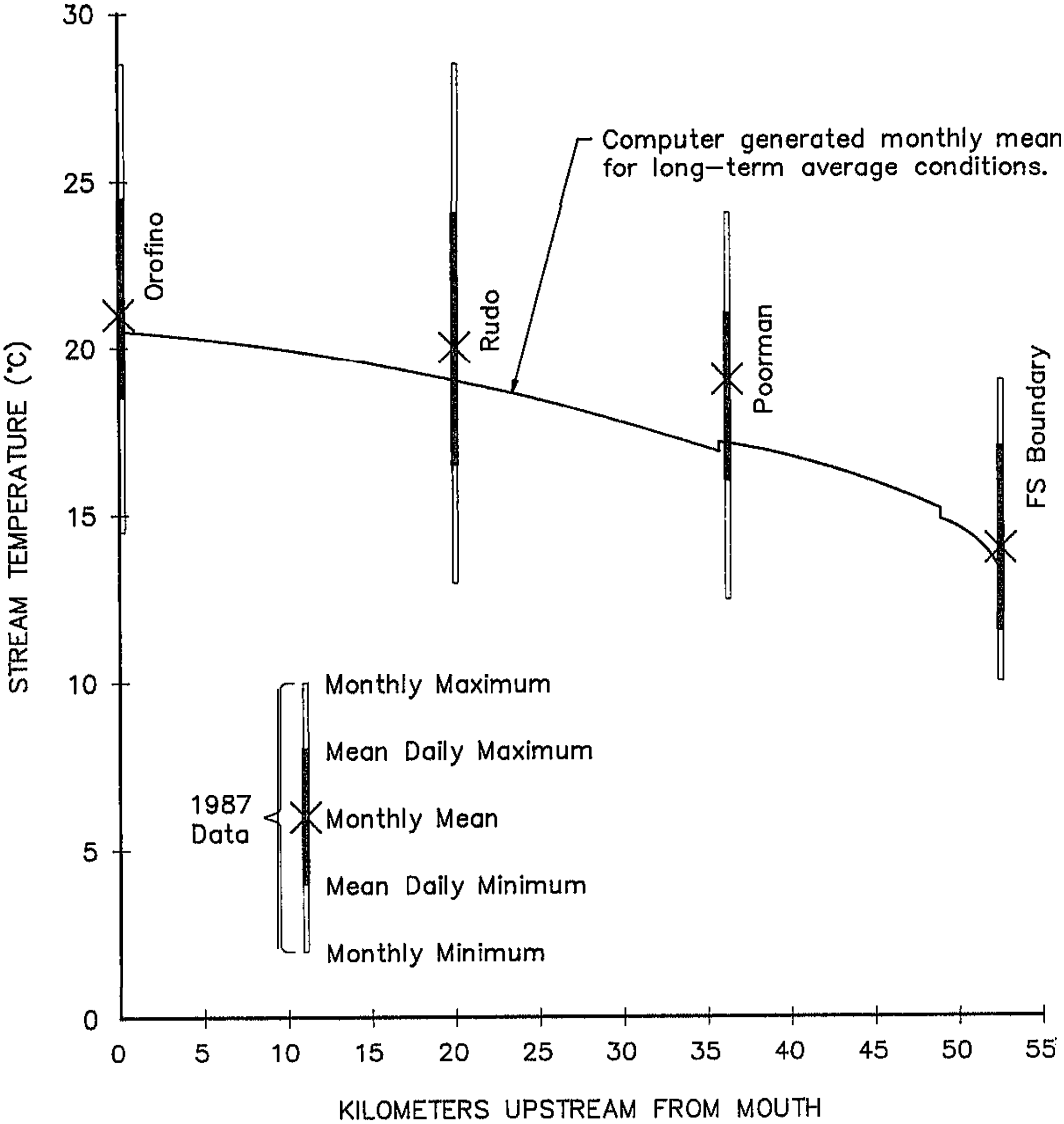

Figure 14. Stream temperatures recorded during July 1987, and predicted for long-term average July conditions in Orofino Creek, Idaho.

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stations. Mean July water temperatures simulated for Orofino Creek at Poorman were about 2 C cooler than those recorded during 1987. Water temperatures simulated for a typical July at Rudo were approximately 1 C cooler than those recorded during July 1987. Mean stream temperatures simulated for long-term average July conditions at Orofino were very similar to the July temperatures recorded during 1987.

Water temperatures simulated for Orofino Creek under long-term average August conditions were similar to those recorded during August 1987 (Figure 15). Given their level of accuracy (about 1 C), the QUAL2E simulations indicate that water temperatures in the stream were not unusually high during August 1987. As well, the August simulations suggest that the high water temperatures recorded in Orofino Creek during late July 1987 were closer to normal than indicated by the July simulations.

Stream temperature data collected on Orofino Creek during 1987 and results of the QUAL2E analyses combine to suggest that strata 1 and 2 usually experience very high water temperatures during July and August. It appears that water temperatures in Stratum 3 are typically high during these two months, but not as extreme as temperatures in strata 1 and 2. In years of low runoff, summer water temperatures in Stratum 4 would be similar to the moderately high temperatures recorded at Poorman during 1987. In years of average runoff, stream temperatures in Stratum 4 would be moderate during most of July, but close to those of 1987 during late July and August. Summer water temperatures in Stratum 5 are typically cool, reflecting good stream shading and close proximity to the headwaters of Orofino Creek.

Thermal Refugia

As the study progressed, we observed small groups of salmonids clustered in suspected thermal refugia along Orofino Creek. The presence of these refuges within the warmer strata of Orofino Creek might affect the ability of juvenile and adult anadromous salmonids to deal with high water temperatures. Consequently, we measured water temperatures at the bottoms of potential adult holding pools and at a variety of other locations within study strata 1, 2 and

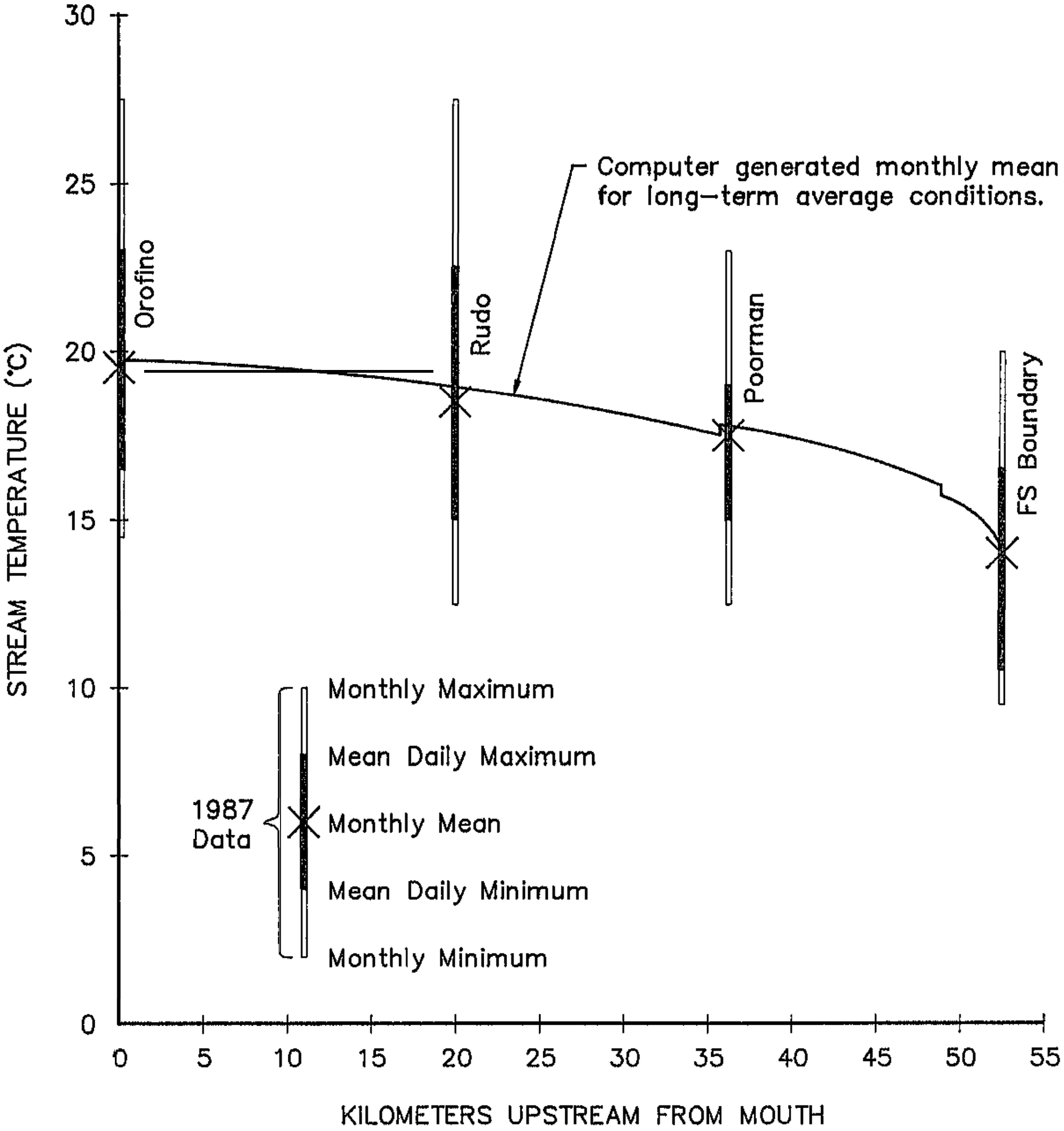

Figure 15 Stream temperatures recorded during August 1987, and predicted for long-term average August conditions in Orofino Creek, Idaho.

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3. We found no evidence of thermal stratification or cooler water in holding pools as deep as 3 meters. Thermal refuge was occasionally provided at the mouths of cool tributaries in strata 2 and 3, but the areas of affected stream were very small. Groundwater seeps along the stream margin in certain areas of Stratum 1 provided cool water that attracted juvenile steelhead.

RESIDENT FISH POPULATIONS

During August, 170 individual habitat units were sampled at 23 stations within the seven study strata. Quantitative estimates of the numerical densities of trout in the habitat units (Appendix C; Tables C-l and C-2) were expanded to estimate the number and average numerical densities of trout in each stratum. Qualitative data collected at the stations describe the distribution and relative abundance of fish species amoung strata.

Salmonids present in the Orofino Creek drainage are rainbow/steelhead trout (_Salmo gairdneri_), brook trout (_Salvelinus fontinalis_), bull trout (_Salvelinus confluentus_) and westslope cutthroat trout (_Salmo clarki_). Rainbow and brook trout were sampled frequently during this study, but only one, angler-caught individual of each of the other two species was observed. Bull trout and westslope cutthroat appear to be rare in areas of the drainage which might be accessible to anadromous fish.

Salmonids were distributed throughout the seven study strata, but relatively uncommon in the lower reaches of Orofino Creek (Table 9). In contrast, temperature-tolerant species of non-salmonids dominated fish assemblages in lower reaches of Orofino Creek and exhibited generally decreasing abundance in the upstream direction. This dominance by temperature-tolerant fishes in the stream's lower reaches is a strong indication that the high temperatures observed there during this study were not an unusual condition. IDFG attempted to increase trout production by poisoning the stream with rotenone in August 1963 and restocking it with trout (B. Bowler, pers comm.). The rotenone treatment failed to remove the non-salmonid fishes.

Table 9. Distribution and relative abundance[1] of fish species in seven strata of streams within the Orofino Creek drainage, summer 1987.

		Relative Abundance of Species in Stratum						
		Orofino Creek					Above Falls Tributaries	
Species	Observed Elevation Range	Below Orofino Falls	Orofino Falls-Lightning Creek	Lightning Creek-Upper Falls	Upper Falls-Pierce	Above Pierce	Lower	Upper
rainbow trout (*Salmo gairdneri*)	310-1220	2	1	3	3	4	5	3
brook trout (*Salvelinus fontinalis*)	605-1220	0	1	2	2	4	3	5
smallmouth bass (*Micropterus dolomieui*)	310-440	3	0	0	0	0	0	0
northern squawfish (*Ptychocheilus oregonensis*)	310-440	4	0	0	0	0	0	0
redside shiner (*Richardsonius balteatus*)	310-770	4	4-5	2-3	0	0	0	0
longnose dace (*Rhinichthys cataractae*)	3x-990	5	5	5	4	c-2	0-l	0-2
speckled dace (*Rhinichthys osculus*)	310-990	5	5	5	4	0-3	0-2	0-3
bridgelip sucker (*Catostomus columbianus*)	310-975	3	2	2	3	c-2	0-1	0-l
sculpins (*Cottus spp.*)	310-1070	2	3	4	3	0-4	c-4	0-4

1 - Relative abundance rated as: 0=not present; 1=very few; 2=few; 3=common; 4=moderately abundant; 5=abundant.

Non-salmonids in the Orofino Creek drainage include smallmouth bass (Micropterus dolomieui), northern squawfish (Ptychocheilus oregonensis), redside shiner (Richardsonius balteatus), longnonse dace (Rhinichthys cataractae), speckled dace (Rhinichthys osculus), bridgelip sucker (Catostomus columbianus) and sculpins (Cottus spp.). dace were the most abundant fish in mainstem Orofino Creek below Pierce (strata 1-4) but their abundance declined significantly in the mainstem above Pierce (Stratum 5) and in the tributaries (strata 6 and 7). Redside shiners, a strong competitor with trout at high water temperatures (Reeves 1985), are restricted to mainstem habitat below the Upper Falls (strata l-3) and are particularly abundant between Orofino Falls and Lightning Creek (Stratum 2). Smallmouth bass and northern squawfish are restricted to habitat below Orofino Falls (Stratum 1).

Based on length-frequencies which were later confirmed by scale analysis, three age classes of rainbow and brook trout were identified during the snorkel-census and electrofishing efforts. Age 0+ trout were less than ll.0cm fork length during August, age l+ trout were generally between 11.0 and 17.5cm fork length, and trout at least two years old exceeded 17.5cm fork length (Figure 16). Age l+ and older trout were grouped together as "overyearling fish" to simplify discussion of their abundance.

Estimated total numbers and average numerical densities of trout in the seven strata show distinct between-stratum differences in trout abundance (Table 10; Figure 17). Trout densities and abundance generally increased in the upstream direction. Trout densities were far lower in strata 1 through 4 than in strata 5 through 7, reflecting poor seeding of habitat and warm water temperatures in mainstem Orofino Creek below Pierce.

Trout were most abundant and found at the greatest densities in Stratum 7 (117,600 fish; 64.16 fish/100 square meters). Average numerical densities of trout were lowest in Stratum 2 (0.25/100 square meters). Trout were less abundant in Stratum 1 (411 fish) than in Stratum 2 (614 fish) despite a slightly higher average numerical density (0.39/100 square meters) due to between-stratum differences in total habitat area.

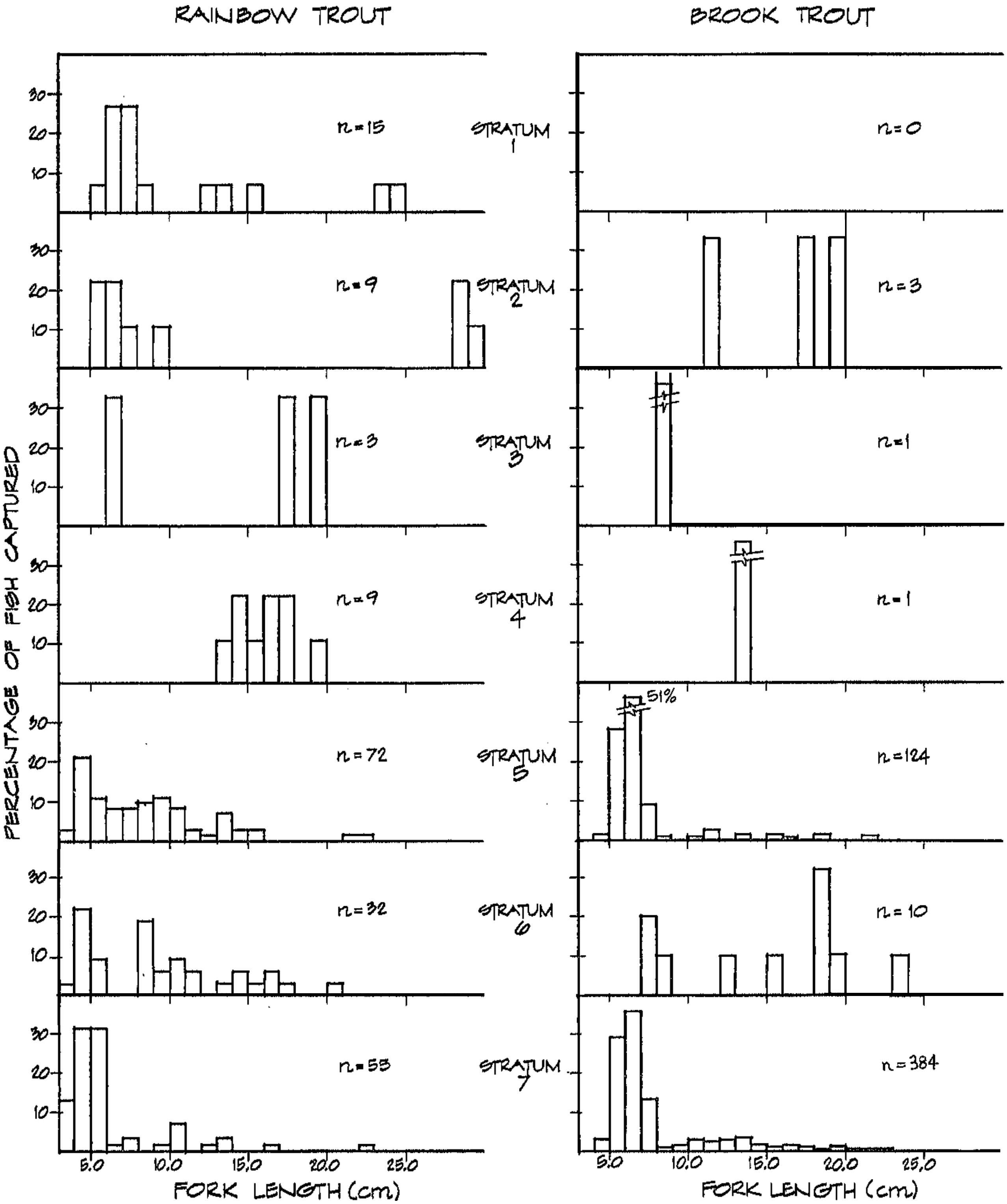

Table 16. Length-frequency of trout electrofished from habitat within seven strata of streams in the Orofino Creek drainage, Idaho, August 1987.

Table 10. Estimated numbers of trout in seven strata of stream within the Orofino Creek drainage, August 1987.

Stream/Stratum	Estimated Number of Rainbow Trout		Estimated Number of Brook Trout	
	Age 0+	Overyearling	Age 0+	Overyearlings
Orofino Creek				
1. Below Orofino Falls	313	98	0	0
2. Orofino Falls-Lightning Cr.	446	102	0	66
3. Lightning Cr.-Upper Falls	1,947	373	4	60
4. Upper Falls-Pierce	334	1,147	0	46
5. Above Pierce	6,437	2,194	9,641	2,412
	9,477	3,914	9,645	2,584
Above Falls Tributaries				
6. Lower Tributaries	1,810	1,722	292	335
7. Upper Tributaries	8,315	1,342	75,364	33,981
	10,125	3,064	75,656	34,316

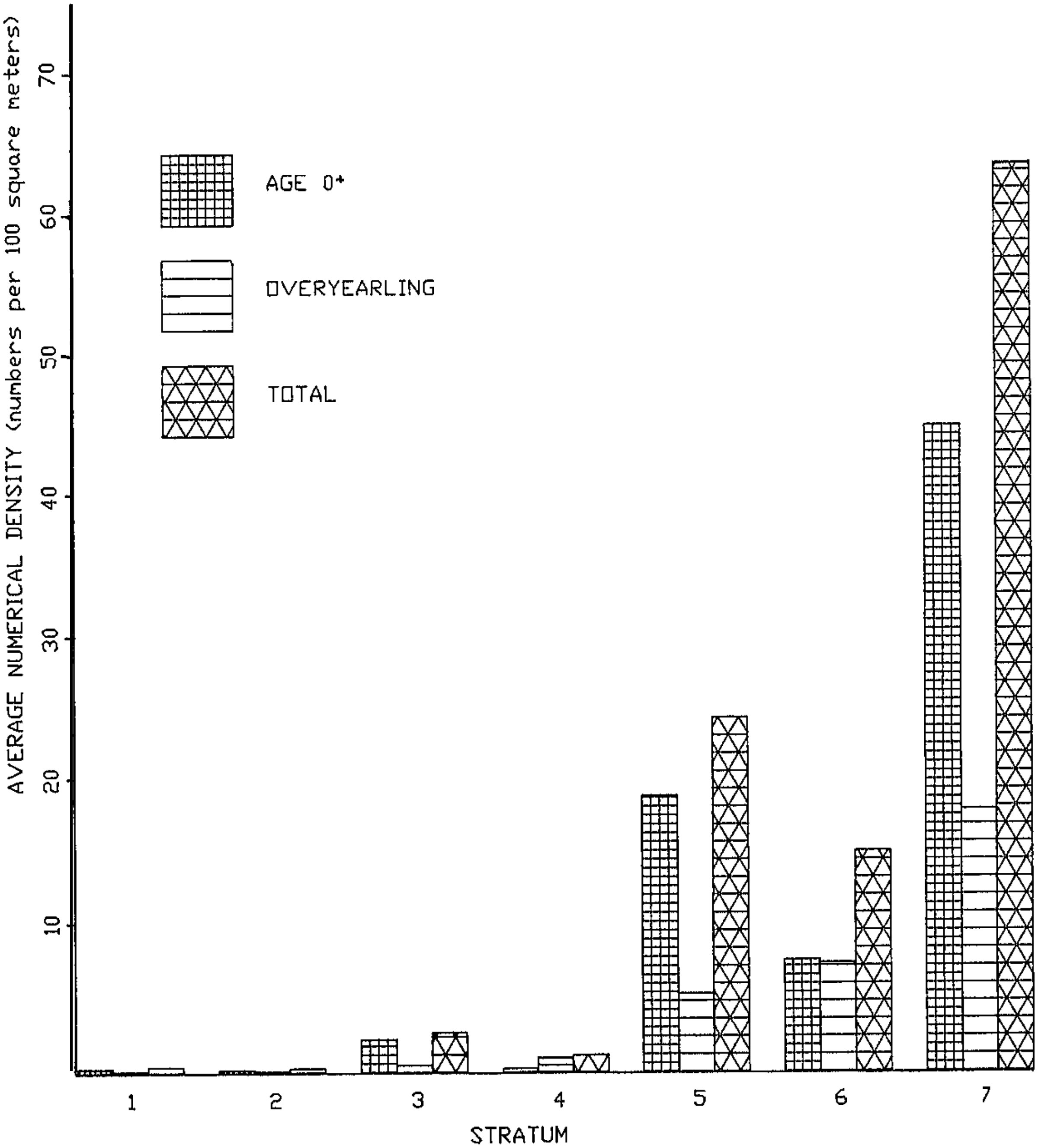

Table 17. Estimated average numerical densities (numbers per 100 square meters) of trout in seven strata of streams within the Orofino Creek drainage, Idaho, August 1987.

Rainbow trout were more abundant than brook trout in mainstem Orofino Creek below Pierce (strata l-4) and in Stratum 6. Brook trout were estimated to be slightly more abundant than rainbow trout in Stratum 5 and much more abundant than rainbow trout in Stratum 7.

Trout Abundance Within Strata

Stratum 1. Rainbow/steelhead trout were the only salmonid species found in mainstem Orofino Creek below Orofino Falls. Average densities of Age 0+ and overyearling trout were 0.30 and 0.09 per 100 square meters, respectively. Rainbow/steelhead were most concentrated in shaded habitats along the stream margin, where high water temperatures may have been reduced by cool groundwater seeps.

Stratum 2. Rainbow trout were the predominant salmonid in Orofino Creek between Orofino Falls and Lightning Creek. Brook trout were found only in or adjacent to spring-fed ponds and sidechannels. Average densities of age 0+ and overyearling rainbow trout were 0.19 and 0.04 per 100 square meters, respectively. Average densities of overyearling brook trout were 0.02 per 100 square meters. No age 0+ brook trout were found in the stratum.

Stratum 3. The average numerical density of trout in mainstem Orofino Creek between Lightning Creek and the Upper Falls was 2.77 per 100 square meters. Average densities were highest for age 0+ rainbow trout (2.27 fish/100 square meters), followed by overyearling rainbow trout (0.43), overyearling brook trout (0.07) and age 0+ brook trout ($0.01).

Stratum 4. The average numerical density of trout in Orofino Creek between the Upper Falls and Pierce was estimated to be 1.18 per 100 square meters. Rainbow trout were the predominant salmonids in the stratum. Estimated average densities were highest for overyearling rainbow trout (0.88 fish/100 square meters), followed by age 0+ rainbow trout (0.26) and overyearling brook trout (0.04). No age 0+ brook trout were observed in Stratum 4, although previous investigators (Johnson 1985) have reported their presence there.

Stratum 5. In contrast to downstream areas of Orofino Creek, where rainbow trout were dominant, Stratum 5 had slightly higher numerical densities of brook trout than of rainbow trout. Reasons for the greater abundance of brook trout were not readily apparent. The average numerical density of all trout was 25.02 fish per 100 square meters. Average densities were highest for age 0+ brook trout (11.67 fish /lOO square meters), followed by age 0+ rainbow trout (7.79), overyearling brook trout (2.92) and overyearling rainbow trout (2.65).

Stratum 6. Rainbow trout were the predominant salmonids in Stratum 6. Average numerical densities of age Ot and overyearling rainbow trout were 6.81 and 6.48 per 100 square meters, respectively. Average densities of age 0+ and overyearling brook trout were 1.09 and 1.26 per 100 square meters, respectively.

Stratum 7. Brook trout were far more numerous than rainbow trout in Stratum 7. We estimate that brook trout comprised 92% of all trout and 96% of overyearling trout in the stratum. Average numerical densities were highest for age 0+ brook trout (41.10 fish/100 square meters), followed by overyearling brook trout (17.80), age 0+ rainbow trout (4.53) and overyearling rainbow trout (0.73).

Effect of High Mainstem Temperatures on Trout Growth

There was no evidence that high water temperatures were retarding trout growth in the lower reaches of Orofino Creek. Despite low numerical densities, overyearling rainbow trout in strata 1, 2 and 3 were in good condition (Figure 18; Table 11) and appeared to be growing at a rapid rate. Scale samples taken in August from trout within the three strata gave no indication of slowed growth during periods of high stream temperatures. Age 2+ rainbow trout sampled from strata 2 and 3 during August all exceeded 27.5cm fork length, indicating good growth rates. These large trout may be feeding heavily on abundant redside shiners, a high quality food source.

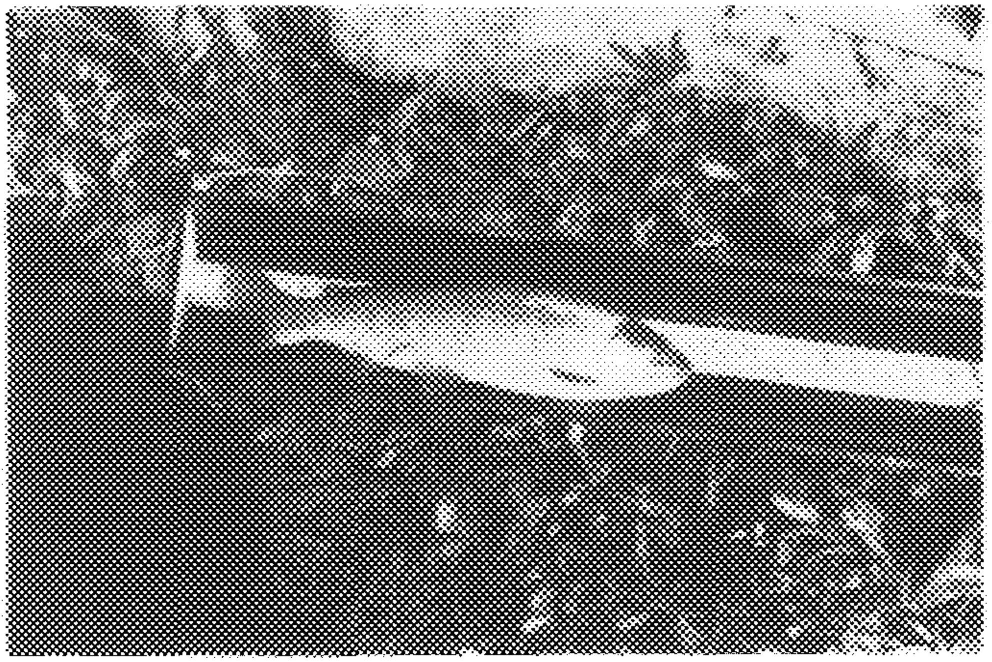

Figure 18. Typical 2-year old rainbow trout from Stratum 2 (Orofino Creek between Orofino Falls and Lightning Creek).

Table 11. Mean lengths and condition factors of overyearling rainbow trout sampled by electrofishing in seven strata of streams within the Omfino Creek drainage, August 1987.

Stream/Stratum	Number Sampled	Mean Fork Length (cm)	Mean Condition Factor (K)
Orofino Creek			
1. Below Orofino Falls	5	15.8	1.01
2. Falls-Lightning Cr.	2	28.8	1.35
3. Lightning Cr.-Upper Falls	2	28.0	1.27
4. Upper Falls-Pierce	9	16.0	1.20
5. Above Pierce	16	13.7	1.09
6. Lower Tributaries	11	13.6	1.21
7. Upper Tributaries	9	12.7	1.07

$K=(wt/l^3)x100$

Overyearling trout in Stratum 1 were generally smaller and less robust than those in strata 2 and 3. This difference could reflect more stressful stream temperatures within Stratum 1. However,. it is possible that the difference is simply due to the presence of anadromous rainbow trout (steelhead) below Orofino Falls and only resident rainbow trout above the falls. Steelhead tend to have a more lean body form and lower condition factors than do resident rainbow trout.

Fish Diseases and High Stream Temperatures

Trout sampled from two streams in the Orofino Creek drainage during August exhibited the external symptoms of diseases often associated with warm water temperatures. Approximately one-third of the overyearling brook trout in lower Rhodes Creek showed the distinctive abdominal swelling, reddening at the base of fins and exopthalmos ("pop-eye") caused by bacterial kidney disease (BKD). A high percentage of rainbow and brook trout in lower Quartz and lower Rhodes creeks had Ichtyophthiriasis ("Ich"). In both streams, the diseased fish were found where trout densities were relatively high and maximum water temperatures often exceeded 20 C.

Trout found in lower Orofino Creek (strata 1-3) during August showed no external symptoms of disease, even where maximum water temperatures sometimes exceeded 28 C. The apparent lack of disease in the fish may have been due to very low population densities, extreme thermal tolerance, or rapid mortality of diseased fish (leaving only disease-free fish to be observed).

FACTORS AFFECTING ADULT SPRING CHINOOK

Low Streamflows

Minimum streamflows required for adult chinook passage at five typical shallow riffles in the Orofino Creek drainage ranged from 0.85 to 1.98 cms (Table 12). Flows at each riffle during July and August 1987 failed to meet minimum passage requirements. Comparisons between limited available streamflow data on Orofino

Table 12. Minimum streamflows required to meet upstream passage requirements for adult spring chinook at five stations in the Orofino Creek drainage, Idaho.

Station	Minimum Flow Allowing Upstream Passage at the Station (cms)	(cfs)	Flow at Orofino Falls (cfs)
Orofino Cr. abv. Whiskey Cr (SK 5.2)	1.13	40	40
Orofino Cr. blw. Falls (SK 8.1)	1.13	40	40
Orofino Cr. nr. Cedar Cr. (SK 15.4)	1.98	70	70
Orofino Cr. at Pierce (SK 47.0)	1.13	40	55
Lower Rhodes Cr. (SK 1.1)	0.85	30	125

cms = cubic meters per second; cfs = cubic feet per second

Creek and the flows required for upstream passage of adult spring chinook at the five typical riffles suggest:

1. Long-term average June and July streamflows estimated for Orofino Creek by Warnick (1984), which appear to reflect conditions during years of moderately high or greater runoff, would allow adult chinook to pass through the shallow riffles examined in Orofino Creek.

2. Long-term average August streamflows estimated for Orofino Creek by Warnick (1984), which also appear to reflect conditions during years of moderately high or greater runoff, would allow marginal fish passage through the shallow riffles below Orofino Falls but not through the riffles above Orofino Falls.

3. During 1982, a year of high runoff, the shallow riffles examined in Orofino Creek would have allowed adult chinook passage through mid-July.

4. During 1985, shallow riffles in Orofino Creek would have blocked adult chinook migrations below Upper Falls after late June.

5. During 1986 and 1987, shallow riffles in Orofino Creek would have blocked adult chinook migrations below Upper Falls after early June.

6. In years of average or low runoff, shallow riffles below Orofino Falls will usually prevent adult chinook that hold in the Clearwater River during July and early August from migrating up Orofino Creek in late August or early September.

7. Adult spring chinook that spend the summer holding in deep pools within Stratum 4 will be unable to spawn in Stratum 5 because of poor upstream passage conditions at shallow riffles. The fish will have to spawn in areas very close to the pools in which they hold during summer.

8. In years of average or low runoff, adult chinook will be unable to pass through shallow riffles in lower Rhodes Creek after late May.

9. Any spring chinook which manage to reach adult holding pools in Quartz or Rhodes creeks will find it very difficult to spawn due to low streamflows and poor passage conditions in most riffles during late summer.

Although the exact migration timing of a future spring chinook run in Orofino Creek is uncertain, it would be reasonable to expect the run to migrate at about the same time as a similar run in a nearby stream. Lo10 Creek, which drains a watershed similar and adjacent to that of Orofino Creek, supports a spring chinook run which usually migrates up the stream during June through mid-July. If a future Orofino Creek run had migration timing similar to that of the Lo10 Creek run, it would often experience severe problems reaching areas above Upper Falls. In many years, a large portion of the run would be unable to reach holding pools or spawning habitat in strata 4 and 5. During years of low runoff, like 1987, most of the run might fail to reach Upper Falls.

An Orofino Creek run would have to migrate up the stream in May and early June in order to consistently reach holding areas above Upper Falls. Development of this early migration timing would be difficult, given that spring chinook don't generally begin their upstream migration in nearby Lo10 Creek until June. Strong pressures would select against fish with inappropriate migration timing, but the selection process would be costly in terms of adult mortality and reduced spawning success. Continual outplanting would be required to maintain a chinook run while attempting to develop appropriate migration timing. Unfortunately, the outplanting would be somewhat counterproductive in that it would reintroduce unwanted adult return characteristics into the population.

If adult chinook returning to Orofino Creek were diverted into a fish collection facility below Orofino Falls, the run would experience only occasional passage problems at shallow riffles in Stratum 1. These problems would generally be experienced by adults which held in the Clearwater River during summer and attempted to migrate up Orofino Creek just prior to spawning in late August or early September.

Low streamflows would also affect fish passage conditions at structural migration barriers in the Orofino Creek drainage. However, low-flow structural barriers in the drainage were not examined under moderate or high streamflow conditions. Consequently, it is unclear what streamflows are required for adult chinook passage at these barriers or whether some of the barriers would constrain chinook migrations to a greater degree than would shallow riffles.

Water Temperatures

From the QUAL2E analyses (see Figures 14 and 15) it is apparent that typical stream temperatures in Stratum 1 during July and August would be stressful for adult spring chinook attempting to migrate upstream toward Orofino Falls. Estimated mean water temperatures for long-term average conditions in Orofino Creek near its mouth exceeded 19.5 C for both months. Temperatures over 18.3 C (65 F) often cause disease problems, reduced fecundity and even mortality in adult spring chinook (J. Mullan, pers comm.; B. McCloud, pers comm.; B. Cates, pers comm.).

Water temperatures in Orofino Creek were not monitored during May or June, the period during which a self-sustaining spring chinook run would often have to migrate up the stream in order to pass through shallow riffles. This prevented a detailed, QUALZE-based assessment of the degree to which high water temperatures in Orofino Creek might affect the primary upstream migration of a future chinook run. However, data collected in Stratum 1 by the Nez Perce Tribe (Murphy 1985, 1986) indicate that stream temperatures there can occasionally reach 24 C during late June. Temperatures that high would be expected to impede upstream migrations of adult chinook. Thus, it is possible that high stream temperatures would affect the primary upstream migration of a future chinook run during certain years.

Water temperatures in Orofino Creek upstream of Orofino Falls would affect the distribution and spawning success of adult spring chinook within the drainage. Specifically, it appears that:

1. Adult spring chinook in mainstem Orofino Creek between Orofino Falls and Upper Falls (strata 2 and 3) during July and August will be subjected to stressful and potentially lethal water temperatures.

2. Stratum 4 contains the only holding pools in mainstem Orofino Creek which experience summer water temperatures that could long be tolerated by adult spring chinook. However, summer temperatures in these pools would be stressful to adult chinook during years of high runoff and very stressful to adult chinook during years of low runoff. Female chinook which dealt with the high summer temperatures in these pools would experience reduced egg viability and spawning success (B. McCloud, pers comm.). During low water years, many fish might die from temperature-induced outbreaks of BKD.

3. Stratum 5 is relatively shallow and lacks holding pools for adult spring chinook. However, the stratum experiences water temperatures during summer that would be appropriate for adult chinook. Spring chinook adults might attempt to hold in Stratum 5, despite shallow stream depths and a lack of holding pools, to take advantage of its relatively cool water temperatures. However, any fish doing so would risk harassment from placer miners, fishermen and residents of nearby Pierce.

Water Quality

The Idaho Department of Health and Welfare (IDHW 1980) and the Nez Perce Tribe (Johnson 1985) have analyzed water quality in streams throughout the Orofino Creek drainage. State water quality standards for turbidity, iron and fecal coliform bacteria have sometimes been violated in lower mainstem Orofino Creek. State standards for other water quality variables are generally met within the drainage. Available water quality data give no indication of problems that would impede or prevent upstream migrations of adult spring chinook.

FACTORS LIMITING PRODUCTION

Summer Steelhead

Future production of summer steelhead in potentially accessible reaches of Orofino Creek will be limited by several factors affecting rearing conditions for juvenile fish. Production in strata 1,2 and 3 will be limited primarily by high water temperatures, low base flows, poor stream shading, competition with redside shiners, and a low amount of pool habitat. Steelhead production in Stratum 4 will be constrained primarily by low base flows and limited pool habitat. Production in Stratum 4 will be affected to a lesser degree by poor stream shading, moderately high stream temperatures and minor streambed sedimentation caused by ongoing use of suction dredges. Steelhead production in Stratum 5 will be limited mainly by a low amount of high quality pool habitat and secondarily by moderate cobble embeddedness.

Steelhead production in potentially accessible reaches of Orofino Creek tributaries will also be limited by a variety of factors. Production in Stratum 6 (Lower Tributaries) will be constrained by low base flows and a general lack of high quality pools. Steelhead production in Stratum 7 (Upper Tributaries) will be limited by low base flows, moderately high levels of cobble embeddedness, the presence of vigorous brook trout populations and the composition of available habitat. Most fish habitat in Stratum 7 appears much better suited to brook trout production than to steelhead production. Steelhead are likely to find it very difficult or impossible to displace a significant portion of the large brook trout populations now in the stratum.

Three structural migration barriers would restrict the distribution of steelhead within Stratum 7 if passage was enhanced only at Orofino Falls and the Upper Falls. Modification of the following additional barriers would be necessary to allow summer steelhead access to all habitat within the study strata:

1. Jaype Mill dam at SK 4.7 on Quartz Creek (Stratum 7)
2. Duffy Dam at SK 1.3 on Canal Gulch (Stratum 7)
3. a minor log jam at SK 0.4 on Trapper Gulch (Stratum 7)

The Trestle Falls on Orofino Creek (SK 33.5) may at times significantly delay upstream migrations of adult steelhead. Fish passage conditions at the falls are anticipated to be poor at streaflows of about 3-15 cms (l00-525 cfs).

Spring Chinook

Production of juvenile spring chinook within areas of the Orofino Creek drainage which might become accessible to adult fish would be limited by the same factors that will constrain juvenile steelhead production plus inconsistent adult access. Juvenile chinook would be much more likely than steelhead to utilize any brook trout-dominated habitat (eg. ponds, backwaters, glides, etc.) accessible to them in Stratum 7 due to their habitat preferences. However, juvenile chinook would be unlikely to utilize habitat in strata 1, 2 or 3 to any significant degree during summer because of high water temperatures. Lindsay et al. (1986) found that juveniles of a temperature resistant stock of spring chinook avoided rearing habitat where weekly mean maximum stream temperatures exceeded 21-22 C.

Despite the presence of suitable spawning and rearing habitat above Orofino Falls, the Orofino Creek drainage will probably not support a self-sustaining run of spring chinook. This opinion is based on adverse conditions adult chinook will often face after entering the drainage and the precarious status of Idaho's wild stocks of spring chinook. Runs of spring chinook in Idaho streams having near-optimum conditions for both juvenile and adult fish are now either barely maintaining themselves or very slowly recovering from severely depressed levels. It would seem unreasonable to expect a stock introduced to the Orofino Creek drainage to sustain itself when adult fish would frequently be exposed to stressful and sometimes lethal conditions.

Three factors affecting adult chinook would combine to prevent the development of a self-sustaining run of spring chinook in Orofino Creek. First, poor upstream passage conditions for adult chinook would prevent some fish from reaching available holding pools and spawning habitat upstream of Upper Falls. The number of fish failing to reach this habitat would vary from year to year, and might include most of the run during low flow years. Fish failing to reach the habitat would be unlikely to contribute many progeny to the next generation. Second, available adult holding pools in mainstem Orofino Creek have summer water temperatures which would be stressful to adult chinook. Female chinook holding in these pools would at best suffer reduced egg viability. Many fish might die from temperature-induced outbreaks of BKO. Finally, low streamflows during the spawning period (late August - early September) would restrict fish use of spawning habitat and at times expose them to a substantial risk of harassment or predation.

Given the difficulties that would be faced by adult spring chinook above Orofino Falls, it seems that the most reasonable way to produce spring chinook in the Orofino Creek drainage would be through a program of juvenile outplanting. The program might be coupled with a fish collection facility below Orofino Falls, so that returning adult fish could be spawned at a hatchery and their offspring used to help maintain the run. Collection or harvest of adults below the falls would prevent their exposure to stressful or perhaps lethal conditions above the falls during summer.

ESTIMATES OF POTENTIAL STEELHEAD SMOLT PRODUCTION

Six separate methods were developed to estimate the potential for steelhead smolt production in areas of the Orofino Creek drainage which may become accessible to summer steelhead through passage enhancement. The methods were used to calculate production estimates for the habitat above Orofino Falls which would become accessible to summer steelhead given two different levels of passage enhancement (Figure 19):

1. Improvement of passage conditions only at Orofino Falls and the Upper Falls.

2. Passage enhancement at three additional migration barriers to allow steelhead access to the remainder of habitat available within the study strata.

Construction of a fish passage facility at Orofino Falls and improved passage conditions at the Upper Falls would allow anadromous fish access to considerably more habitat than is now available in Orofino Creek below Orofino Falls (Table 13). We estimated that 54.3 km of mainstem Orofino Creek and 30.4 km of tributary streams would be opened to anadromous salmonids. These lengths of stream contain over 680,000 square meters of salmonid rearing habitat during summer low flow. Most of this habitat is structurally well-suited to produce juvenile salmonids. However, production of summer steelhead or spring chinook within lower reaches of mainstem Orofino Creek will be severely constrained by high water temperatures in summer.

Passage improvements at three migration barriers upstream of Upper Falls would make an additional 18.9 km of Orofino Creek tributaries accessible to anadromous salmonids (Table 14). Most of the added habitat would be in the Quartz Creek and Canal Gulch drainages, each of which has been subjected to major disturbances by historic timber harvest and dredge mining activities. Pools and ponds would comprise most of the added rearing habitat in these two drainages.

Estimation Methodologies

Method 1. Number of overyearling resident trout. The number of overyearling (age 1 and older) rainbow trout in areas to be made accessible to anadromous fish above Orofino Falls was used as an estimate of potential yearling steelhead production. The rationale for this method is that

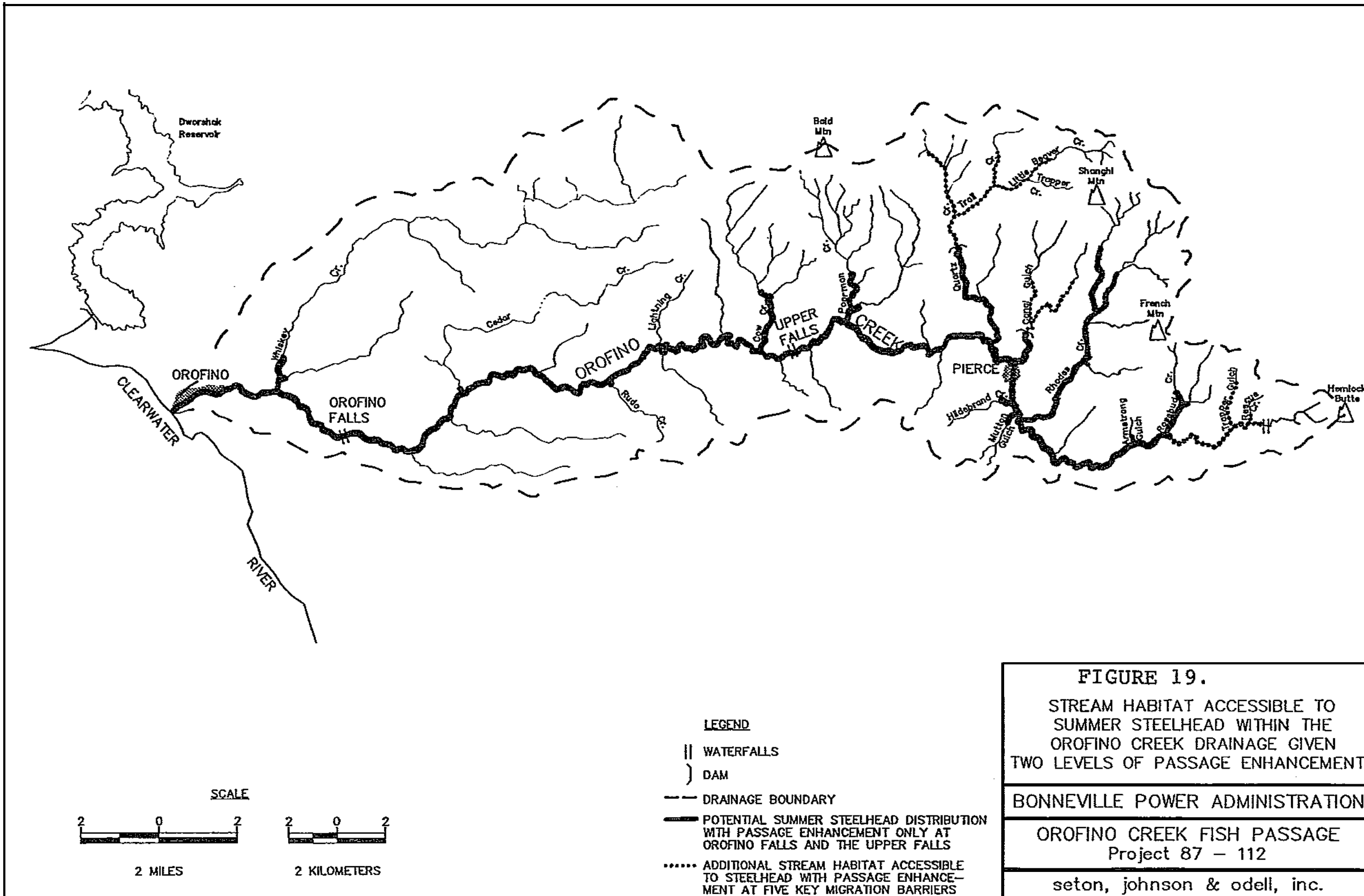

FIGURE 19.

STREAM HABITAT ACCESSIBLE TO SUMMER STEELHEAD WITHIN THE OROFINO CREEK DRAINAGE GIVEN TWO LEVELS OF PASSAGE ENHANCEMENT

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

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Table 13. Available rearing habitat in Orofino Creek below Orofino Falls and currently unavailable habitat that will become accessible to summer steelhead if passage is provided to Orofino Falls and the Upper Falls.

Stream/Stratum	Stream Length (km)	Pools	Ponds	Riffles	Runs	Pocket-waters	Glides	Side-channels	Back-waters	TOTAL
		Surface Area (square meters)								
Orofino Creek										
1. Below Orofino Falls	a.3	8,046	0	48,510	15,986	26,886	1,173	1.417	1,823	103,841
2. Falls-Lightning Cr.	17.6	26,869	697	138,179	21,485	25,902	5,699	7,779	2,800	229,410
3. Lightning-Upper Falls	7.0	15,075	0	45,213	6,795	11,438	2,144	4,169	1,081	85,915
4. Upper Falls-Pierce	13.5	27,795	0	50,751	11,789	25,560	10,538	2,124	2,363	130,920
5. Above Pierce	16.2	12,425	1,118	41,616	6,049	10,245	7,380	2,354	1,439	82,676
Above Orofino Falls	54.3	82,164	1,815	275,809	46,118	73,145	25,761	16,426	7,683	528,921
6. Lower Tributaries[1]										
Cedar Cr.	0.2	73	0	30	2	5	0	0	0	110
Rudo Cr.	0.1	18	0	58	15	0	0	0	0	91
Cow Cr.	2.8	1,740	0	3,328	948	205	0	25	25	6,271
Poorman Cr.	2.8	2,065	0	3,475	256	563	25	176	86	6,646
lower Quartz Cr.	3.1	5,039	0	5,588	215	1,984	84	70	468	13,448
	9.0	8,935	0	12,479	1,437	2,757	109	271	579	26,566
7. Upper Tributaries[1]										
upper Quartz Cr.	1.6	2,268	2,977	785	136	0	1,794	a	123	8,061
Canal Gulch	1.3	1,009	0	1,293	321	142	229	106	173	3,273
Pierce Valley Cr.	0.6	0	5,551	0	0	0	188	0	0	5,739
Hildebrand Cr.	0.3	206	889	22	17	114	28	0	a	1,284
Rhodes Cr.	13.1	15,746	49,694	18,260	3,038	713	3,799	1,795	3,383	96,428
Mutton Gulch	0.8	1,220	1,809	64	17	6	53	11	81	3,261
St. Louis Gulch	0.2	a4	0	36	86	0	50	0	0	256
Armstrong Gulch	0.4	226	0	86	14	0	45	3	0	374
Rosebud Cr.	2.5	2,076	2,375	992	293	416	371	680	120	7,323
Trapper Gulch	0.4	114	0	335	25	47	0	0	36	557
Rescue Cr.	0.1	43	0	68	3	15	0	4	3	136
unnamed tributaries	0.1	17	0	8	6	0	0	0	0	31
	21.4	23,009	63,295	21.919	3,955	1,435	6,557	2,607	3,927	126,723

1 - Habitat quantities given are for all accessible streams within each tributary drainage.

Table 14. Additional rearing habitat in the Orofino Creek drainage which will become accessible to summer steelhead if passage is provided at three migration barriers[1] upstream of the Upper Falls at SK 32.9.

Stream/Stratum	Stream Length (km)	Surface Area (square meters) Pools	Ponds	Riffles	Runs	Pocket-waters	Glides	Side-channels	Back-waters	TOTAL
Orofino Creek										
2. Falls-Lightning Cr.	0.0	-	-	-	-	-	-	-	-	-
3. Lightning-Upper Falls	0.0	-	-	-	-	-	-	-	-	-
4. Upper Falls-Pierce	0.0	-	-	-	-	-	-	-	-	-
5. Above Pierce	0.0	-	-	-	-	-	-	-	-	-
Above Orofino Falls	0.0	0	0	0	0	0	0	0	0	0
6. Lower Tributaries[2]										
Cedar Cr.	0.0	-	-	-	-	-	-	-	-	-
Rudo Cr.	0.0	-	-	-	-	-	-	-	-	-
Cow Cr.	0.0	-	-	-	-	-	-	-	-	-
Poorman Cr.	0.0	-	-	-	-	-	-	-	-	-
lower Quartz Cr.	0.0	-	-	-	-	-	-	-	-	-
7. Upper Tributaries[2]										
upper Quartz Cr.	12.5	17,401	3,384	6,798	1.190	310	4,154	552	1,495	35,284
Canal Gulch	4.7	9,342	6,552	909	110	22	1,067	421	268	18,691
Pierce Valley Cr.	0.0	-	-	-	-	-	-	-	-	-
Hildebrand Cr.	0.0	-	-	-	-	-	-	-	-	-
Rhodes Cr.	0.0	-	-	-	-	-	-	-	-	-
Mutton Gulch	0.0	-	-	-	-	-	-	-	-	-
St. Louis Gulch	0.0	-	-	-	-	-	-	-	-	-
Armstrong Gulch	0.0	-	-	-	-	-	-	-	-	-
Rosebud Cr.	0.0	-	-	-	-	-	-	-	-	-
Trapper Gulch	1.7	575	103	1,585	119	129	61	47	35	2,654
Rescue Cr.	0.0	-	-	-	-	-	-	-	-	-
unnamed tributaries	0.0	-	-	-	-	-	-		-	-
	la.9	27,318	10,039	9,292	1,419	461	5,282	1,020	1,798	56,629

1 - Migration barriers which could be modified at reasonable cost to provide access to habitat which may have significant production potential. These barriers include: 1) Jaype Mill dam at SK 4.7 on Quartz Creek; 2) Duffy Dam at SK 1.3 on Canal Gulch; and 3) a minor log jam at SK 0.4 on Trapper Gulch.

2 - Habitat quantities given are for all accessible streams within each tributary drainage.

overyearling steelhead and overyearling resident rainbow trout have similar habitat requirements and preferences. Steelhead should eventually come to occupy most of the accessible habitat now used by resident rainbow trout.

Overyearling steelhead above Orofino Falls would generally spend one additional winter in the drainage before migrating toward the ocean as smolts. For this reason, the estimated numbers of overyearling steelhead were reduced by 40 percent to account for over-winter mortality of pre-smolts. This estimate of potential smolt production was then reduced by an additional 20 percent, to account for competition for food and space between juvenile steelhead and that portion of the resident rainbow trout population expected to persist following the introduction of steelhead (Bjornn 1978).

The estimate of smolt production obtained by this method assumes that current numbers of overyearling rainbow trout above Orofino Falls reflect the productive capacity of available habitat. This assumption may not hold true because fishing mortality and low rates of recruitment appear to affect at least portions of the rainbow trout population above the falls. As well, the abundance of resident rainbow trout in a stream is likely lower than the abundance of steelhead would be because habitat used by resident trout larger than steelhead smolts could be used by a greater number of juvenile steelhead. For the preceeding reasons, this method is thought to yield a conservative (low) estimate of the potential for steelhead production above Orofino Falls.

Method 2. Number of overyearling resident trout. The methodology of this estimate was similar to that of Method 1, except that: 1) the numbers of overyearling rainbow and brook trout in accessible areas above the falls were used as the basis for predicting smolt production; and 2) all overyearling brook trout residing in pond habitat were assumed to persist after the introduction of steelhead rather than being replaced to some significant degree by juvenile steelhead. No information found in the literature suggests that introduced steelhead will have any success in displacing brook trout from this type of habitat.

Numbers of overyearling rainbow and brook trout in accessible habitat (excluding ponds) above the falls were reduced by 20 percent to account for competition between introduced juvenile steelhead and persistent resident trout. The resultant number of fish, amounting to 80 percent of the current population of overyearling resident trout (excluding those in ponds), is an estimate of the potential for overyearling steelhead production. Potential smolt production was calculated by applying a 60 percent over-winter survival factor (Reimers 1957; Maciolek and Needham 1951) to the estimate of overyearling steelhead production.

When applied to accessible habitat in upper Orofino Creek tributaries (Stratum 7), which tend to have habitat better suited to brook trout production than to steelhead production, this method probably yields smolt estimates which are liberal (high). Bjornn (1978) found that heavy outplanting of juvenile steelhead in Big Springs Creek, Idaho had little effect upon a resident brook trout population. Method 2 may be conservative when applied to mainstem Orofino Creek downstream of Pierce (strata l-4), for the same reasons that Method 1 is believed to be conservative.

Method 3. Numerical densities of overyearling steelhead in nearby Lo10 Creek. Lo10 Creek is adjacent to Orofino Creek. It drains a larger watershed with a land-use history similar to that of Orofino Creek and supports a sizeable run of wild summer steelhead. Lower Lo10 Creek experiences high water temperatures similar to, but not as severe as, those of Orofino Creek (A. Espinosa, pers. comm.). Upper Lolo Creek has cool water temperatures and relatively high quality salmonid habitat. The stream is considered underseeded with juvenile steelhead due to inadequate escapements of spawners (Petrosky and Holubetz 1986).

Surface areas of accessible habitat in the Orofino Creek drainage were multiplied by the highest recently observed numerical densities of overyearling steelhead in habitat of similar quality within the Lo10 Creek drainage. The highest densities were used in an effort to account for recent underseeding of habitat. Overyearling densities observed during summer by IOFG in upper Lo10 Creek (12.3 fish/100 square meters; Petrosky and Holubetz 1986) were applied to the total surface area of accessible rearing habitat (excluding ponds) in strata 5, 6 and 7. Resultant estimates of potential overyearling production were then reduced by 20 percent of the number of overyearling trout currently in that habitat (excluding ponds), to account for competition between introduced steelhead and persistent resident trout. Smolt production was estimated by multiplying the reduced overyearling estimates by 0.4 (Slaney 1981), to account for a large component of age 2+ fish within the population of juvenile steelhead in upper Lo10 Creek.

Numerical densities of yearling steelhead observed during summer in lower Lolo Creek (2.1 fish/100 square meters; C. Johnson, pers. comm.) were applied to the total surface area of available rearing habitat in strata 2, 3 and 4. Resultant estimates of potential overyearling steelhead production were reduced by 20 percent of the existing overyearling trout population, to account for persistent resident trout. Potential production of smolts was then estimated using a 60 percent over-winter survival rate for overyearling fish. The 60 percent rate was felt to be appropriate because the great majority of overyearling steelhead in lower Lo10 Creek are age 1 fish.

Potential smolt production estimated by this method could be either liberal or conservative, depending upon: 1) how well the highest observed rearing densities of overyearling steelhead in Lo10 Creek reflect that stream's (and Orofino Creek's) productive capacity; and 2) the degree to which temperature regimes differ between the two streams. This method is believed to be one of the more reliable of those used to estimate the smolt production potential of Orofino Creek.

Method 4. Numerical densities of yearling steelhead in specific habitat types within Idaho streams. This methodology used data recently collected on summer rearing densities of juvenile steelhead within specific habitat types (pools, riffles, runs and pocketwaters) in 20 Idaho streams (Dr. T. Bjornn, unpubl. data). Habitat quality in each of the 20 streams is considered good (Dr. T. Bjornn, pers comm.). The upper end of the range of 20 stream-specific mean rearing densities for yearling steelhead in each habitat type was selected to represent the productive capacity for that habitat type (Table 15).

Table 15. Numerical densities of yearling (age 1+) summer steelhead within specific habitat types in 20 relatively infertile Idaho streams tributary to the Clearwater and Snake rivers, 1986 (Dr. T.C. Bjornn. unpubl. data).

Habitat Type	Number of units Examined	Yearling Steelhead (number/100 square meters) Mean	Fully Seeded Habitat [1]
Poole	204	3.53	10
Riffles	216	2.03	4
Runs	223	2.43	9
Pocketwaters	14	5.75	11

1 - The numerical density given for "fully seeded habitat" of a given type represents the higher end of the range of mean densities observed in 20 individual streams.

Numerical rearing densities of yearling steelhead determined by the method just described were applied to weighted areas of habitat types classified during the stream inventory. The total surface area of each habitat type within each stratum was weighted to account for differences between the temperature regimes and habitat quality of each stratum and those of the 20 Idaho streams. The factors incorporated results of lab studies by Reeves (1985) indicating reduced overyearling steelhead production at warm versus cool temperatures and more greatly reduced production when warm temperatures were coupled with the presence of redside shiners.

Weighting factors applied to habitat in each stratum were: 0.1 for Stratum 2; 0.6 for Stratum 3; 0.8 for Stratum 4; and 1.0 for strata 5, 6 and 7. Rearing densities for riffles were applied to areas of sidechannel habitat. Pond and backwater habitats in the drainage, which contain very few overyearling rainbow trout during summer, were assumed to contribute little to the potential for yearling steelhead production. Glide habitat in Orofino Creek below Pierce (strata l-4) also had little potential for yearling steelhead production. Rearing densities for runs were applied to glide habitat in Orofino Creek above Pierce (Stratum 5) and in Orofino Creek tributaries (strata 6 and 7).

The estimated number of yearling steelhead that all accessible habitat within a given stratum could support in summer was reduced by 20 percent of the estimated number of overyearling resident trout currently in the stratum (excluding pond habitat). This accounted for future competition between juvenile steelhead and persistent resident trout. Potential smolt production was then estimated by multiplying the reduced number of yearling steelhead by a 60 percent over-winter survival factor.

Method 4 is considered one of the best methods of the six used to estimate steelhead production potential. It takes good account of both habitat composition and habitat quality in the study strata.

Method 5. Numerical densities of overyearling steelhead in fully seeded Lochsa River tributaries. Forest Service data collected during summer on four tributaries to the Lochsa River, Idaho suggest that when fully seeded, the streams can support approximately 30 overyearling steelhead per 100 square meters of high quality overyearling habitat (A. Espinosa, pers comm). Because a large percentage of the overyearling steelhead in these four streams are age 2+ fish (A. Espinosa, unpubl. data), it would be reasonable to expect approximately 40 percent of the overyearlings to leave the stream as smolts after an additional winter (Slaney 1981). Thus, the US Forest Service data indicate a potential production level of about 12 steelhead smolts per 100 square meters of high quality overyearling habitat.

Surface areas of habitat types considered to be high quality overyearling habitat were pooled within each study stratum to allow calculations of smolt production potential. Habitat classified as either pool (excluding ponds), run or pocketwater in Orofino Creek strata between Orofino Falls and Pierce was considered high quality overyearling habitat. Habitat classified as pool (excluding ponds), run, pocketwater or glide in Orofino Creek above Pierce and in Orofino Creek tributaries was also considered high quality overyearling habitat. The surface area of high quality overyearling habitat within each stratum was then weighted by the same habitat weighting factors used in Method 4. Potential smolt production of a given study stratum was estimated by multiplying its weighted area of high quality habitat by 12 steelhead smolts per 100 square meters. This estimate was then adjusted downward to account for competition between introduced steelhead and persistent resident trout.

Method 5 is believed to yield reasonable estimates of the potential for smolt production in most areas of the Orofino Creek drainage. The method probably overestimates the production potential of Stratum 7 which is dominated by pool-type habitat.

<u>Method 6. Numerical densities of overyearling steelhead in small tributaries to the lower Clearwater River</u>. Several small tributaries to the lower Clearwater River have been studied by the Nez Perce Tribe (Kucera and Johnson 1986) and shown to support moderate to high summer densities of overyearling steelhead. Like Orofino Creek, these streams experience very low flows and high water temperatures in summer. However, temperatures in the streams do not apparently get as high as those in Orofino Creek, perhaps due to somewhat better stream shading. These streams are considerably smaller and

more productive (l00-150 percent greater total dissolved solids) than Orofino Creek, suggesting that they should support substantially greater numerical densities of juvenile steelhead than can Orofino Creek.

Numerical densities of overyearling steelhead in these small, sometimes intermittent streams were applied directly to the total surface areas of accessible habitat in each stream strata above Orofino Falls. Densities observed in the lower reaches of the small streams (8.2 fish/100 square meters) were applied to surface areas of habitat (excluding ponds) in Orofino Creek between Orofino Falls and Pierce (strata 2-4). Densities observed in the upper reaches of the small streams (27.9 fish/100 square meters) were applied to surface areas of habitat (excluding ponds) in strata 5, 6 and 7. Resultant estimates of potential overyearling steelhead production were then reduced by 20 percent of the current population of resident trout (excluding those in ponds), to account for competition between introduced steelhead and persistent resident trout. Smolt production was calculated by multiplying the estimated potential for overyearling steelhead production by a 60 percent over-winter survival factor.

Smolt production estimates resulting from the use of Method 6 should be considered very liberal because of differences in stream productivity and stream temperatures between Orofino Creek and the small streams studied by the Nez Perce Tribe.

Production Estimates

The six estimates of potential steelhead production for habitat that will become accessible to summer steelhead if passage is enhanced solely at Orofino Falls and Upper Falls (Table 16) ranged from 3,018 (Method 1) to 52,094 smolts (Method 6). Estimates based on existing resident trout populations (Methods 1 and 2) are considered low because existing trout populations in mainstem Orofino Creek below Pierce seem significantly affected by angling mortality and low levels of juvenile seeding. The high estimate obtained by Method 6 serves more as a remotely possible level of smolt production than as a realistic estimate of production potential. The smolt production estimates obtained by

Table 16. Estimates of the potential for steelhead smolt production in habitat within the Orofino Creek drainage which will become accessible to summer steelhead if passage is provided at Orofino Falls aud the Upper Falls.

	Potential Smolt Production By Stream Strata						Estimated
	Orofino Creek				Above Falls Tributaries		Smolt Production
Estimation Method	Orofino Falls-Lightning Cr.	Lightning Cr.-Upper Falls	Upper Falls-Pierce	Above Pierce	Lower	Upper	Above Orofino Falls
1. number of overyearling rainbow trout	49	179	551	1,053	827	359	3,018
2. number of overyearling resident trout	81	208	573	2,076	987	3,904	7,829
3. numerical densities of overyearling steelhead in nearby Lolo Cr.	2,870	1,031	1,506	3,494	1,060	1,700	11,661
4. numerical densities of yearling steelhead in specific habitat types within Idaho stream	779	1,875	4,054	2,628	854	1,213	11,403
5. numerical densities of overyearling steelhead in fully seeded Lochsa River tributaries	871	2,346	6,098	3,813	1,341	3,150	17,619
6. numerical densities of overyearling steelhead in small tributaries to the lover Clearwater R.	11,164	4,159	6,248	13,100	7,166	10,257	52,094

methods 3, 4 and 5 seem most reasonable on the basis of observations made in the field. Thus, a realistic range of estimates for the steelhead production potential of the habitat would be 11,403 to 17,619 fish.

Estimates of the additional production potential of habitat which could be made accessible to steelhead by modifying three key barriers upstream of Upper Falls ranged from 285 to 6,240 smolts (Table 17). The estimate of 285 smolts, calculated using Method 1, is thought to represent a best approximation of the potential for greater production. The low estimate is considered best because of the strong predominance of brook trout habitat and brook trout in the additional areas to become accessible to steelhead. We suspect that steelhead would have little success penetrating these brook trout zones, and therefore used current rainbow trout abundance within the zones as an indicator of potential steelhead production.

Combining our best smolt production estimates for each of the two levels of passage enhancement yields estimates of potential steelhead production for all habitat within strata 2 through 7. The combined estimates range from 11,688 to 17,904 steelhead smolts. We consider the average of these combined estimates, 13,846 smolts, the overall best estimate of the potential for summer steelhead production above Orofino Falls.

Interest has been expressed in an estimate of the smolt production potential of Stratum 1 (Orofino Creek below Orofino Falls). We estimated this potential assuming the habitat weighting factor of Stratum 2 and using Methods 2, 3 and 4 (the three considered most reasonable). Resultant estimates of potential smolt production range from 420 (Method 4) to 1296 (Method 3). The average of estimates obtained by the three methods is 772 smolts. This estimated potential for smolt production does not account for juvenile steelhead which might migrate between Orofino Creek and the Clearwater River to avoid high summer water temperatures.

Table 17. Estimates of the potential for steelhead smolt production in habitat available above five migration barriers[1] upstream of the Upper Falls at SK 32.9 on Orofino Creek.

Estimation Method	Potential Smolt Production: Quartz Cr.	Canal Gulch	Trapper	Estimated Smolt Production Above Three Additional Migration Barriers
1. number of over-yearling rainbow trout	198	18	9	285
2. number of overyearling resident trout	2,433	1,067	96	3,596
3. numerical densities of overyearling steelhead in nearby Lolo Cr.	1,256	478	104	1,838
4. numerical densities of yearling steelhead in specific habitat types within Idaho streams	1,224	526	14	1,824
5. numerical densities of overyearling steelhead in fully seeded Lochsa River tributaries	2,213	1,011	85	3,309
6. numerical densities of overyearling steelhead in small tributaries to the lover Clearwater R.	4,272	1,626	342	6,240

1 - Migration barriers which could be modified at a reasonable cost to provide access to habitat which may have significant production potential. These barriers include: 1) the Jaype Mill dam at SK 4.7 on Quartz Creek; 2) puffy Dam at SK 1.3 on Canal Gulch: and 3) a minor log jam at SK 0.8 on Trapper Gulch.

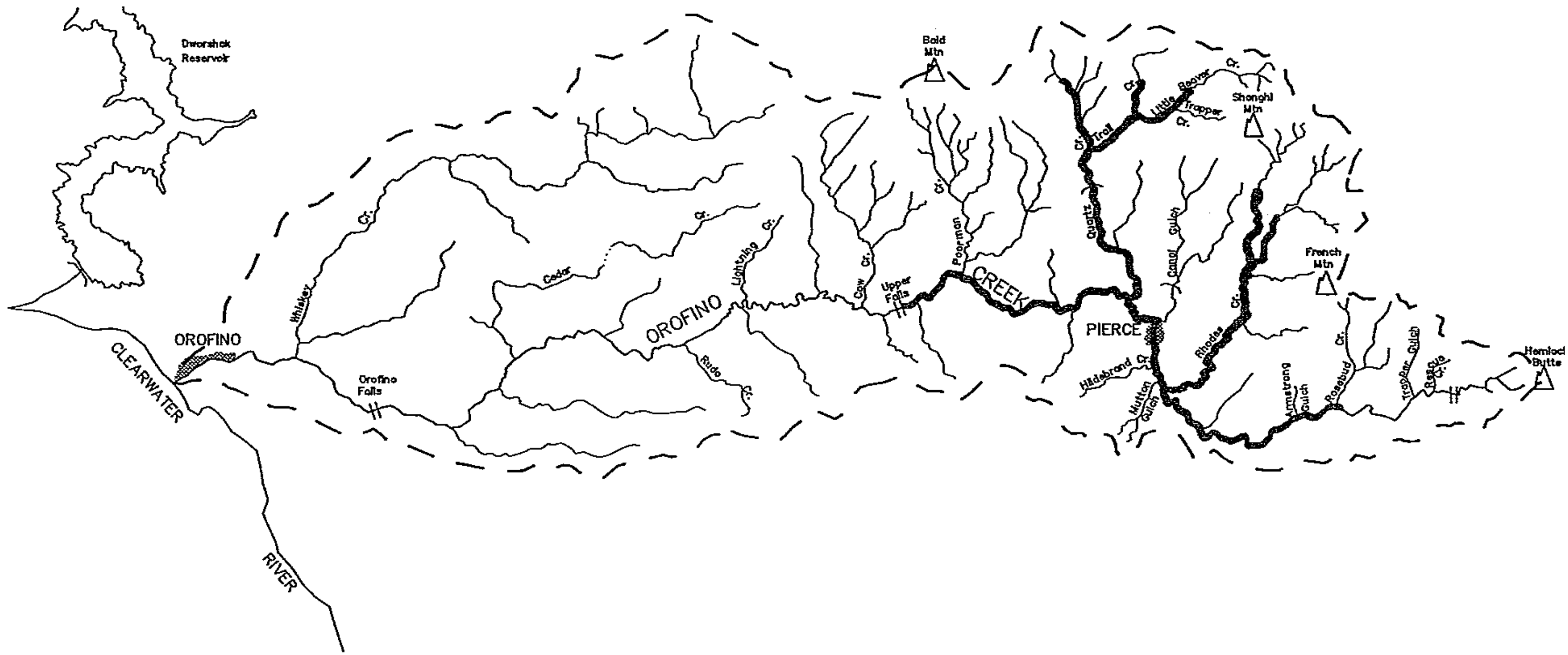
ESTIMATES OF POTENTIAL SPRING CHINOOK SMOLT PRODUCTION

Two methods were used to estimate the potential for production of chinook smolts in Orofino Creek and tributary drainages which might become accessible to adult spring chinook in years of high runoff after implementation of an extensive barrier removal program (Figure 20; Table 18). It is noted that natural seeding of much of this habitat, particularly that in Orofino Creek tributaries, would be inconsistent. Thus, the two methods were used to estimate production levels that could be maintained only through continual outplanting of juvenile chinook. As indicated earlier, it is not believed that the Orofino Creek drainage will support a self-sustaining run of spring chinook.

Estimation Methodologies

Method 1. Numerical densities of age 0+ spring chinook in Idaho streams. This estimation methodology used data recently collected on summer rearing densities of juvenile spring chinook within specific habitat types (pools, riffles, runs and pocketwaters) in 20 Idaho streams (Dr. T. Bjornn, unpubl. data). The upper end of the range of 20 stream-specific mean rearing densities for age 0+ spring chinook in each habitat type was selected to represent the productive capacity for that habitat type (Table 19).

Numerical rearing densities of age 0+ chinook determined by the method just described were applied to weighted areas of habitat types classified during the stream inventory. The total surface area of each habitat type within each stratum was weighted to account for differences between the temperature regimes and structural habitat quality of each stratum and those of the 20 Idaho streams. Weighting factors were: 0.0 for Orofino Creek below Upper Falls (strata l-3); 0.6 for Orofino Creek between the Upper Falls and Pierce (Stratum 4); 0.5 for the Upper Tributaries (Stratum 7); and 1.0 for strata 5 and 6. The factors were different than those used for steelhead production because it is anticipated that juvenile spring chinook will be less tolerant of high stream temperatures and will compete directly with age O+ brook trout for food and space. Competition with brook trout would be most intense in Stratum



LEGEND

|| WATERFALLS

} DAM

— — DRAINAGE BOUNDARY

━━ POTENTIAL SPRING CHINOOK DISTRIBUTION

SCALE

2 0 2
2 MILES

2 0 2
2 KILOMETERS

FIGURE 20.

POTENTIAL SUMMER REARING DISTRIBUTION OF JUVENILE SPRING CHINOOK SALMON WITHIN THE OROFINO CREEK DRAINAGE, IDAHO

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

seton, johnson & odell, inc.

Table 18. Potentially accessible (and suitable) summer rearing habitat for juvenile spring chinook salmon in the Orofino Creek drainage, Idaho.

Stream/Stratum	Stream Length (km)	Surface Area (square meters)								
		Pools	Ponds	Riffles	Runs	Pocket-waters	Glides	Side-channels	Back-waters	TOTAL
Orofino Creek										
1. Below Orofino Falls	0.0		—			—	—	—	—	—
2. Falls-Lightning Cr.	0.0	—	—	—	—	—	—	—	—	—
3. Lightning-Upper Falls	0.0	—	—	—	—	—	—	—	—	—
4. Upper Falls-Pierce	13.5	27,795	0	50,751	11,789	25,560	10,538	2,124	2,363	130,920
5. Above Pierce	11.5	8,329	1,118	33,374	4,272	5,228	7,190	1,951	850	62,312
Above Orofino Falls	29.0	36,124	1,118	84,125	16,061	30,788	17,728	16,023	4,075	193,232
Lower Tributaries[1]										
lower Quartz Cr.	3.1	5,039	0	5,588	215	1,984	84	70	468	13,448
Upper Tributaries[1]										
upper Quartz Cr.	14.1	19,669	6,361	7,583	1,326	310	5,948	560	1,618	43,345
Rhodes Cr.	13.1	15,746	49,694	18,260	3,038	713	3,799	1,795	3,383	96,428
	27.2	35,415	56,055	25,843	4,364	1,023	9,747	2,355	5,001	139,803

1 - Habitat quantities given are for all accessible streams within each tributary drainage.

Table 19. Numerical densities of subyearling (age 0+) spring chinook salmon within specific habitat types in 20 relatively infertile Idaho streams tributary to the Clearwater and Snake rivers, 1986 (Dr. T.C. Bjornn, unpubl. data).

Habitat Type	Number of Units Examined	Subyearling Chinook (number/100 square meters) Mean	Fully Seeded Habitat[1]
Pools	204	21.7	70
Riffles	216	4.6	10
Runs	223	13.6	50
Pocketwaters	74	9.1	20

1 - The numerical density given for "fully seeded habitat" of a given type represents the higher end of the range of mean densities observed in 20 individual streams.

7 and we believe juvenile chinook would compete more successfully with brook trout than would rainbow trout (see earlier comments). Rearing densities for riffles were applied to weighted areas of side channel habitat. Rearing densities for pools were applied to weighted areas of all pond and backwater habitats, including large dredge and beaver ponds in Stratum 7. Glide habitat in Orofino Creek below Pierce (strata 1-4) had little potential for juvenile chinook production. Rearing densities for runs were applied to weighted areas of glide habitat in stata 5 and 6.

The estimated number of age 0+ chinook salmon that accessible habitat could support in late summer was reduced by 20% of the estimated number of age 0+ brook trout currently in that habitat. The reductions accounted for future competition between juvenile chinook and persistent brook trout. Potential smolt production was estimated by multiplying the reduced number of age 0+ spring chinook by an overwinter survival factor of 50 percent.

Method 2. Clearwater National Forest Method. Espinosa (1987) has estimated the potential for production of spring chinook smolts in an enhanced reach of Lo10 Creek in the Clearwater National Forest, Idaho using a method based on available summer rearing habitat. The method attributed production of 0.28 smolts to each square meter of "good" pools and 0.09 smolts to each square meter of other usable rearing habitat in "good" condition.

Potential production of spring chinook smolts in potentially accessible areas of the Orofino Creek drainage were estimated by multiplying total weighted areas of each habitat type in each stratum by the appropriate level of smolt production. Surface areas of habitat within each stratum were weighted by the same factors used in Method 1. Production levels of 0.28 smolts/square meter were assumed for weighted areas of pool, pond and backwater habitats. Production of 0.09 smolts/square meter was assumed for weighted areas of all other habitat types except Stratum 4 glides, which had little production potential. The estimates of production potential were reduced to the same degree as those in Method 1 were, to account for competition with brook trout expected to persist after the chinook introduction.

Production Estimates

Our two estimates of potential chinook production for habitat that may become accessible to spring chinook were 35,824 and 36,874 smolts (Table 20). Both estimates are larger than those considered reasonable for potential steelhead smolt production in the six study strata above Orofino Falls. The average of the two estimates, 36,349 smolts, represents a best estimate of production potential. Full realization of this estimated potential would be contingent upon implementation of an outplanting program and juvenile chinook successfully competing with brook trout for food and space in Stratum 7.

FISHERY BENEFITS OF PROJECT IMPLEMENTATION

Summer Steelhead

Potentially accessible habitat in the Orofino Creek drainage above Orofino Falls (strata 2-7) is estimated to be capable of producing a total of 13,846 steelhead smolts. Of this total, 13,561 smolts would be produced by habitat made accessible to steelhead solely through passage enhancement at Orofino Falls and the Upper Falls. Passage would have to be enhanced at three additional migration barriers to realize the remaining production potential of 285 smolts.

Future returns and harvests of adult summer steelhead resulting from the Orofino Creek Passage Project will depend on the potential for smolt production above Orofino Falls, probable survival rates for the stream's steelhead at various stages of their life cycle, and future harvest rates. The appropriate survival and harvest rates were selected assuming that the Orofino Creek steelhead run will be derived from B-run Clearwater River stock and that mainstem passage conditions in the Columbia and Snake rivers will be improved in the future per the goals of the Columbia River Basin Fish and Wildlife Program (Table 21). It is estimated that each wild fish which spawns in the drainage above Orofino Falls will contribute 54 smolts to the progeny year class of summer steelhead. Wild summer steelhead smolts from Orofino Creek are anticipated to return as adults to the Clearwater River at a rate of 2.41%.

Table 20. Estimates of the potential for spring chinook smolt production in the Orofino Creek drainage, Idaho[1].

	Potential Smolt Production By Stream Strata						Estimated Smolt Production Above Orofino Falls
	Orofino Creek				Above Falls Tributaries		
Estimation Method	Orofino Falls-Lightning Cr.	Lightning Cr.-Upper Falls	Upper Falls-Pierce	Above Pierce	Lower	Upper	
1. numerical densities of subyearling spring chinook in specific habitat types within Idaho streams	0	0	11,222	8,274	2,307	15,071	36,874
2. Clearwater N.F. Method	0	0	12,006	6,221	2,141	15,456	35,824

1 - Assumes implementation of a long-term fry outplanting program. The given levels of smolt production would not be a direct benefit of BPA-funded passage enhancement because of poor conditions for any adult chinook which return to the drainage.

Table 21. Sequential life stage parameters for a future wild stock of B-run summer steelhead in the Orofino Creek drainage, Idaho.

Life Stage Parameter	Relative Numbers of Wild Fish
1. escaping spawners	1
2. eggs per escaping spawner[1]	3600
3. emergent fry (50% survival)	1800
4. smolts above Orofino Falls (3% survival[2])	54
5. smolts below Orofino Falls[3]	54
6. adults returning to below Bonneville Dam (5.19% survival[4])	2.80
7. adults passing Bonneville Dam (95% survival)	2.66
8. adults harvested in Zone 6 set-net fishery (30% mortality[5])	0.80
9. adults escaping Zone 6 set-net fishery (70% survival)	1.86
10. adults passing The Dalles Dam (95% survival)	1.77
11. adults passing John Day Dam (95% survival)	1.68
12. adults passing McNary Dam (95% survival)	1.60
13. adults passing Ice Harbor Dam (95 surival)	1.52
14. adults passing Lower Monumental Dam (95% survival)	1.44
15. adults passing Little Goose Dam (95% survival)	1.37
16. adults passing Lower Granite Dam (95% survival)	1.30
17. adults available to spawn in Orofino Creek or to be harvested in a terminal fishery[6]	1.30

1 - 6,000 eggs/female, 3 females/2 males for B-run steelhead at Dworshak National Fish Hatchery (Howell et al. 1985)

2 - from Bjornn (1978)

3 - assumed no smolt mortality passing downstream over Orofino Falls

4 - USACE (1985) estimate for 1995 conditions, assuming major juvenile passage improvements at mainstem Columbia and Snake river dams as well as full transportation of smolts

5 - estimated Indian gill-net harvest in the Columbia River

6 - represents a 2.41% smolt-to-adult return to Clearwater River (1.30 adults per 54 smolts)

A reasonable scenerio for development of the Orofino Creek steelhead run would involve annually passing enough surplus spawners from Dworshak National Fish Hatchery over Orofino Falls to fully seed available habitat until naturally returning adult fish are capable of doing so. Future returns and harvests of steelhead under this scenerio were modeled assuming the following:

o survival and harvest rates given in Table 21

o adult hatchery steelhead passed over Orofino Falls would have the same same sex ratio anticipated for the developing Orofino Creek stock (3 females: 2 males)

o only enough hatchery fish would be passed over Orofino Falls to ensure full seeding of available habitat

o hatchery supplementation of the run would stop once naturally returning adults could fully seed available habitat

o annual survival and harvest rates would be constant

o each hatcheryXhatchery mating produces only 50% as many smolts and 25% as many returning adults as each wildXwild mating

o adult steelhead which are one or more generations removed from the hatchery are wild fish

o random spawning between hatchery and wild steelhead

o full dispersal of adult and juvenile fish throughout accessible habitat

o each hatcheryXwild mating produces only 75% as many smolts and 62.5% as many returning adults as each wildxwild mating

o all adult B-run steelhead spawn as 5-year olds

- adult steelhead are harvested by the Columbia River Zone 6 Indian set-net fishery at a constant annual rate of 30%

- Only steelhead in excess of the number of returning adults needed to fully seed habitat available above Orofino Falls may be harvested in a terminal fishery (this assumption would be consistent with a current catch-and-release fishery for wild steelhead in the Clearwater River downstream of Orofino Creek)

Adult returns and harvests of Orofino Creek steelhead produced under the assumed run-building scenerio would be expected to first reach their full size after four adult return cycles (Table 22). Summer steelhead produced above Orofino Falls would be harvested in the Zone 6 net fishery and return to Orofino Creek for the first time five years after the initial release of hatchery spawners above the falls. The need for hatchery supplementation of the run would end 15 years after the first release of hatchery spawners, coincident with the first surplus of adult Orofino Creek steelhead returning to the Clearwater River.

Assuming enhancement of adult fish passage only at Orofino Falls and the Upper Falls, the fully developed run would support a Zone 6 harvest of 201 fish and return 327 potential spawners to the Clearwater River. Of the 327 fish returning to the Clearwater, 76 (23%) could be harvested without reducing smolt production above Orofino Falls. It would take an estimated 251 spawners to fully seed habitat available above the falls.

Spring Chinook

The Orofino Creek drainage will probably not support a self-sustaining run of spring chinook due to adverse conditions for adult fish and the precarious status of Idaho's wild stocks of chinook. Sustained production of spring chinook above Orofino Falls would therefore be expected to require continual outplanting of juvenile fish to seed available habitat. It is unclear how the fishery benefits of such an outplanting program would relate to the Orofino Creek Passage Project.

Table 22. Hatchery supplementation, harvests and returns of Orofino Creek steelhead under the run-building scenerio assumed for the Orofino Creek Passage Project. Figures outside parentheses represent adult numbers if fish passage is enhanced only at Orofino Falls and the Upper Falls. Figures in parentheses represent adult numbers if passage is also enhanced at three key migration barriers above the Upper Falls.

Category of Adult Steelhead	Adult Return Cycle 1 (year 1-5)	2 (year 6-10)	3 (year 11-15)	4 (year 16-20)	>4 (year >20)
adults harvested by Zone 6 fishery	0 (0)	100 (103)	149 (152)	194 (198)	201 (205)
adults returning to Clearwater R.	0 (0)	163 (167)	242 (247)	315 (322)	327 (307)
need for adult supplementation	502 (513)	148 (166)	18 (18)	0 (0)	0 (0)
surplus adults available for terminal harvest	0 (0)	0 (0)	0 (0)	64 (66)	76 (78)

BASIS FOR PROJECT IMPLEMENTATION

This section summarizes key results of the biological feasibility study and important considerations which will affect implementation of the Orofino Creek Passage Project.

1. Existing smolt production, existing potential for smolt production and potential with passage improvement.

There is currently no smolt production in the drainage above Orofino Falls because the falls block upstream passage of anadromous salmonids. Production potential in Orofino Creek below the falls is estimated at 772 smolts. It is believed that current production is below capacity.

Potentially accessible habitat above Orofino Falls is estimated to be capable of producing 13,846 summer steelhead and 36,349 spring chinook salmon smolts annually. The Orofino Creek Passage Project would increase annual steelhead production by 13,561 to 13,846 smolts, depending on the level of passage enhancement above the falls (assuming availability of seeding stock). Project-related increases in the production of spring chinook smolts are unclear, due to a suspected inability of the Orofino Creek drainage to support a self-sustaining run of spring chinook salmon.

2. Existing escapement and potential escapement.

Orofino Creek now supports a very small run of summer steelhead which is blocked at Orofino Falls. The stream does not currently produce spring chinook salmon.

Project implementation will, depending on barrier removal activities above Orofino Falls, increase annual steelhead escapement to the Clearwater River by an estimated 327 to 334 fish. Project-related increases in spring chinook escapement are unclear at this time.

3. Existing wild and naturally spawning stock trends and conditions.

There is little information on the history of fish runs in Orofino Creek. The stream has probably always supported a relatively minor run of summer steelhead below Orofino Falls. There are no records of Orofino Creek supporting a population of spring chinook (Varley and Diggs 1983).

Naturally-spawning stocks of steelhead and spring chinook in the Clearwater River drainage have declined from historic levels due primarily to hydro-electric development and secondarily to habitat degradation. In the mid-1970's, the stocks were depressed to the point of facing potential extinction (Espinosa 1983). Since that time there have been major efforts directed toward restoring the Clearwater's runs of wild fish. Wild stocks of steelhead within the drainage have responded reasonably well to those efforts and have shown significant recovery. Recovery of the drainage's naturally-spawning spring chinook stocks has been slow. Many of the wild stocks of chinook now have remnant status (IDFG 1985).

4. Benefits to multiple anadromous species and runs.

The project's passage enhancement measures will benefit summer steelhead and perhaps spring chinook. Benefits to spring chinook would depend on the relationship between a fish passage facility at Orofino Falls and a program to continually outplant juvenile chinook into the Orofino Creek drainage.

5. Extent and condition of habitat available through passage enhancement.

Anadromous fish use of Orofino Creek is currently restricted to 8.3 km of stream below Orofino Falls. Low streamflows and very high water temperatures in this section of stream during summer limit its potential to produce steelhead or salmon.

Implementation of the project would allow anadromous fish access to an additional 84.7 to 103.6 km of habitat, depending on the level of passage enhancement above Orofino Falls. The added habitat would be of poor to good quality for spawning and rearing of steelhead and salmon. Generally poor adult passage and holding conditions above the falls would be a chronic problem expected to prevent development of a self-sustaining run of spring chinook.

Low summer flows, limited riparian vegetation and high stream temperatures reduce habitat quality in much of mainstem Orofino Creek above the falls. Some streams in the upper watershed have habitat that is dominated by brook trout and may be poorly utilized by anadromous fish.

6. Requirements for hatchery supplementation, including genetic and disease considerations.

Production of summer steelhead or spring chinook above Orofino Falls would be initiated by planting available habitat with fish. The stocks of fish used should be compatible with the Idaho Anadromous Fish Managment Plan (IDFG 1985). The Plan indicates that appropriate stocks for Orofino Creek are B-run Clearwater River steelhead and Rapid River spring chinook.

Summer Steelhead. The probable method of initiating a run of summer steelhead above Orofino Falls would be to release unspawned adults from nearby Dworshak National National Fish Hatchery (DNFH) over the falls. DNFH has an adequate supply of surplus, B-run Clearwater steelhead to make these releases (Bill Miller, pers comm.). Annual releases would begin at about 500 fish, enough to fully seed available habitat with juveniles, and decline as a natural run established itself. It is estimated that all supplementation of the new run would end after three adult return cycles (15 years). Releases could begin before project implementation, to check smolt production prior to passage enhancement and to accelerate project benefits.

DNFH steelhead spawn from late January through May, with half the fish spawning by mid-April (Howell et al. 1985). It may be important to plant some adults predisposed to early spawning in order to obtain full utilization of lower elevation streams within the drainage.

DNFH steelhead have experienced problems with a diversity of fish diseases. These diseases include Ichthyopthirius ("Ich), infectious hematopoietic necrosis (IHN), external parasites and bacterial gill disease (Howell et al. 1985). IHN has been a chronic and acute problem. Exposed to stressful water temperatures, the offspring of DNFH steelhead introduced to some areas of the drainage above Orofino Falls may suffer substantial disease-related mortality. Potential introduction of diseases new to areas above the falls would apparently not be a major concern. Past trout stocking practices by IDFG have already carried the various diseases of Idaho salmonids into the drainage (B. Bowler, pers comm.).

Spring Chinook. An appropriate strategy for outplanting the Orofino Creek drainage with juvenile spring chinook has yet to be determined. The best strategy would depend upon the objective(s) of concerned agencies and tribes. Given that the drainage is not likely to support a self-sustaining run, the relationship between any outplanting program and the passage project is also unclear.

Spring chinook of Rapid River stock will be available for outplanting in the Orofino Creek drainage (B. Bowler, pers comm.; B. Miller, pers comm.). The source of these fish is uncertain at present, but might include Rapid River Hatchery (RRH), the planned Clearwater Hatchery, or an outplanting facility that the Nez Perce Tribe may construct.

Run timing of Rapid River spring chinook varies with locale and is earlier in low flow years than in high flow years. Arrival time at RRH has peaked as early as May 23 and as late as July 16 (Howell et al. 1985). The period of time between the peak and end of the run is greatest (about one month) during low flow years (Howell et al. 1985). Offspring of RRH fish with the earliest run timing would be best adapted to deal with poor passage conditions for adult spring chinook in the Orofino Creek drainage.

There is apparently no major concern that Rapid River spring chinook will carry new diseases into the drainage above Orofino Falls. BKD has been a chronic problem with RRH fish (Howell et al 1985). Other maladies which have affected the stock include bacterial gill disease, coldwater disease, cataracts and sunburn (Howell et al 1985). High water temperatures in certain areas above the falls would be stressful to Rapid River spring chinook and might stimulate outbreaks of disease.

7. Ocean and river harvest management considerations.

Orofino Creek steelhead will be exposed to intense mixed-stock fisheries. The Columbia River Indian gill-net fishery, which has harvested B-run steelhead at rates as high as about 40 percent in recent years (M. Schwartzburg, pers comm.), will capture a relatively large number of Orofino Creek fish. As well, there is a major sport fishery for DNFH steelhead in the lower Clearwater River. The lower Clearwater fishery is currently managed to require release of wild fish. Incidental mortalities of Orofino Creek steelhead caught and released along the lower Clearwater, or changes in the management of the fishery there, will reduce adult returns to Orofino Creek.

Harvest rates of Idaho's spring chinook stocks are currently very low. Fishery closures have been put into effect to allow the low numbers of adult fish returning to Idaho streams to spawn. An Orofino Creek run based on outplanting could be harvested by a terminal fishery without affecting depressed wild spring chinook stocks.

8. Status of diversion screening and requirements for improvement.

There are no major water diversions from streams within the Orofino Creek drainage which might become accessible to anadromous fish. A hydropower project that Clearwater Hydro Ltd. has proposed for Orofino Falls would divert a substantial portion of streamflow to generate electricity. Diversion screening has been accounted for in the design of Clearwater Hydro's project.

9. <u>Effects of the project on resident fish stocks.</u>

Resident fish species in the Orofino Creek drainage include rainbow/steelhead trout, brook trout, bull trout, westslope cutthroat trout, redside shiner, dace, suckers and sculpins. None of the resident fishes are classified as endangered or are unique to the drainage. However, there may be a particularly temperature-resistant stock of rainbow trout in mainstem Orofino Creek above the falls.

Potential effects of the project on resident fish include localized impacts during construction of fish passage facilities and widespread effects of introduced anadromous fish on resident species. Effects of construction would be short-term, and minimized by appropriate construction techniques. Widespread effects above the falls would result from interactions between anadromous and resident fish within the new range of distribution for introduced summer steelhead or spring chinook.

Competition for food and space with introduced anadromous fish will reduce the abundance of resident trout above Orofino Falls. Numbers of wild rainbow trout may decline by as much as 80 percent in areas of overlapping distribution with summer steelhead (Bjornn 1978). Brook trout numbers would decline to a lesser degree. Bull and cutthroat trout are uncommon in areas that might become accessible to salmon or steelhead.

Reductions in the abundance of wild trout above the falls will affect an existing sport fishery of modest intensity. Effects on the fishery could be minimized by leaving several preferred fishing areas inaccessible to anadromous fish. Adverse effects on the fishery could be partially mitigated by increasing plants of hatchery rainbow trout in a few heavily fished areas near the town of Pierce or by improving habitat for resident trout in streams inaccessible to anadromous fish.

10. Emphasis on protection, mitigation and enhancement of upriver stocks of anadromous fish.

The project would provide off-site mitigation for historic losses of Idaho's anadromous salmonids. It would enhance natural production of summer steelhead within the lower Clearwater River drainage, Idaho. In some as yet undefined way, it may facilitate increased production of spring chinook salmon.

11. Plans to protect anadromous salmonids.

Agencies and tribes with an interest in the passage project recognize the importance of managing land-use practices within the Orofino Creek drainage to maintain fish production potential. Any future land-use activities which increase stream temperatures or sedimentation could reduce the drainage's capacity to produce steelhead or salmon.

Private ownership of most (68 percent) of the drainage may pose a difficult problem in the management of its anadromous fish production. Current timber harvest, road construction, grazing and mining activities on private lands have the potential to increase stream temperature or sediment levels. However, the largest landowner, Potlatch Forest Industries (34 percent of drainage), allowed access to its timberlands during the study and might be cooperative with regard to minor changes in harvest practices. Orofino Creek is designated as a Class 2 stream (IDFG 1985). This classification affects activities on private lands by allowing only "short-term impacts due to sediment that would result in a 10 percent reduction from natural production capacity, provided the impacts occur no more than 3 years out of 10, with the expectation of full recovery." It is possible that project implementation would lead to reclassification and greater protection of the stream.

Clearwater National Forest (USFS) contains the most pristine fish habitat within the Orofino Creek drainage. This habitat will be affected by current USFS plans to begin a major timber harvest effort in the upper draiange within the next five years (A. Espinosa, pers. comm.). That effort will have some effect on stream temperature and sediment levels within the National Forest and downstream. Implementation of the fish passage project might alter USFS plans.

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APPENDIX A -- STREAM SURVEY DATA

TABLE A-l. AVAILABLE SUMMER REARING HABITAT IN THE OROFINO CREEK DRAINAGE, IDAHO, 1987

		SURFACE AREA (square meters)							
STREAM	REACH (km)	POOL[1]	RIFFLES	RUNS	POCKET WATERS	GLIDES	SIDE CHANNELS	BACK WATERS	TOTAL
OROFINO CREEK	0.0-5.1	4,030	38,706	9,540	7,681	254	772	1,017	62,000
	5.1-8.3	4,016	9,805	6,446	19,205	920	645	805	41,842
	8.3-15.4	13,489	57,415	4,554	9,749	4,693	4,802	840	95,542
	15.4-16.8	1,692	8,773	2,419	3,158	0	190	468	16,700
	16.8-19.7	4,153	21,700	5,017	1,449	1,006	1,151	a72	35,405
	19.7-22.6	6,092	19,032	5,376	5,297	0	582	468	36,847
	22.6-25.9	2,140	31,259	4,119	6,248	0	1,053	151	44,970
	25.9-29.7	8,417	29,506	3,066	2,394	360	3,133	362	47,238
	29.7-31.6	3,152	9,495	1,948	2,249	1,212	975	549	19,580
	31.6-32.9	3,506	6,212	1,781	6,795	571	61	170	19,095
	32.9-36.4	2,756	19,264	6,504	8,729	1,084	471	638	37,446
	36.4-38.2	6,421	3,684	234	2,857	1,951	471	307	15,925
	38.2-40.0	5,005	396	la4	6,694	382	844	242	13,747
	40.0-42.4	5,627	6,823	3,475	4,141	1,307	145	432	21,950
	42.4-45.1	6,820	12,795	2,570	2,946	2,840	92	694	28,757
	45.1-46.4	1,165	7,790	822	192	2,974	100	50	13,093
	46.4-48.3	1,594	8,302	844	72	2,427	139	201	13,579
	48.3-48.9	627	1,834	190	0	1,419	0	0	4,070
	48.9-51.7	2,857	8,548	1,143	727	1,714	683	304	15,976
	51.7-55.4	2,184	10,535	1,218	2,004	959	307	268	17,475
	55.4-57.5	1,937	3,439	566	2,107	672	822	59	9,604
	57.5-60.2	2,367	5,463	1,713	3,066	145	l87	295	13,,236
	60.2-61.1	279	1,959	156	1,533	25	144	155	4,251
	61.1-62.0	895	1,154	153	574	0	59	114	2,949
	62.0-62.9	804	432	67	162	20	14	45	1,544
QUARTZ CREEK	0.0-3.1	5,039	5,558	215	19	84	70	468	13,448
	3.1-4.9	5,245	755	137	0	1,795	a	123	8,063
	4.9-6.4	6,831	1,014	0	0	557	55	53	8,510
	6.4-10.0	4,465	321	31	0	1,703	81	1,090	7,691

1 - includes pond habitat

TABLE A-l Continued

		SURFACE AREA (square meters)							
STREAM	REACH (km)	POOL1	RIFFLES	RUNS	POCKET WATERS	GLIDES	SIDE CHANNELS	BACK WATERS	TOTAL
LITTLE BEAVER CR.	0.0-1.7	1,541	1,159	493	67	842	348	8	4,458
	1.7-3.3	1,346	1,063	173	64	174	57	65	2,942
TRAIL CREEK	0.0-2.6	4,632	2,723	465	178	730	0	229	8,965
	2.6-3.8	1,970	509	22	0	223	3	50	2,777
TRAPPER GULCH	0.0+	0	8	6	0	8	0	0	22
CANAL GULCH	0.0-1.3	1,009	1,293	321	142	229	106	173	3,273
	1.3-1.7	6,494	198	36	22	20	64	0	6,834
	1.7-2.6	3,186	117	15	0	170	11	89	3,588
E FK CANAL GULCH	0.0-3.4	6,215	594	59	0	878	346	179	8,271
ROSEBUD CREEK	0.0-1.4	3,227	716	176	84	340	418	36	4,997
	1.4-2.3	755	237	106	332	14	67	84	1,595
JENSON CR.	0.0-0.2	468	39	11	0	17	195	0	730
POORMAN CREEK	0.0-1.1	814	2,179	178	262	25	95	59	3,612
	1.1-1.8	420	897	78	249	0	47	28	1,798

1 - includes pond habitat

TABLE A-l Continued

STREAM	REACH (km)	SURFACE AREA (square meters) POOL[1]	RIFFLES	RUNS	POCKET WATERS	GLIDES	SIDE CHANNELS	BACK WATERS	TOTAL
McCAULEY CR.	0.0-1.0	831	396	0	53	0	33	0	1,313
UNNAMED TRIBUTARY	0.0	17	8	6	0	0	0	0	31
RHODES CREEK	0.0-1.7	1,664	3,924	744	98	223	98	148	6,899
	1.7-7.5	55.475	10.903	1,524	524	1.945	858	2,245	73,474
	7.5-8.2	3,829	674	33	0	170	686	382	5,774
	8.2-9.4	3,799	1,028	284	22	315	39	0	5,487
UNNAMED TRIBUTARY	0.0-0.2	280	67	6	0	0	0	0	353
CLEARWATER GULCH	0.0-0.3	393	195	36	0	11	0	0	635
SHANGHAI CREEK	0.0-3.2	5,437	1,469	410	70	1,134	114	609	9,243
COW CREEK	0.0-2.8	1,741	3,321	948	203	0	25	25	6,263
SKINNER CR.	0.0+	0	7	0	1	0	0	0	8

1 - includes pond habitat

TABLE A-l Continued

STREAM	REACH (km)	SURFACE AREA (square meters) POOL1	RIFFLES	RUNS	POCKET WATERS	GLIDES	SIDE CHANNELS	BACK WATERS	TOTAL
HILDEBRAND CREEK	0.0-0.)	1,095	22	17	114	28	0	8	1,284
TRAPPER CREEK	0.0-0.8	329	794	60	176	0	0	43	1,402
	0.8-2.1	463	1,126	84	0	61	47	28	1,809
CEDAR CREEK	0.0-0.2	146	60	4	10	0	0	0	110
RUDO CREEK	0.0-0.1	18	58	15	0	0	0	0	91
FLAT CREEK	0.0-0.8	1,098	75	8	0	70	0	3	1,254
MUTTON CR,	0.0-0.8	3,029	64	17	6	53	11	81	3,261
ST. LOUIS CREEK	0.0-0.2	84	36	86	50	0	0	0	256
ARMSTRONG CREEK	0.0-0.4	226	86	14	0	45	3	0	374
RESCUE CR.	0.0-0.1	43	78	3	15		4	3	136

1 - includes pond habitat

TABLE A-2. HABITAT PARAMETERS FOR SURVEYED REACHES OF STREAMS IN THE OROFINO CREEK DRAINAGE, IDAHO, 1987.

STREAM	REACH (km)	PERCENT SHADE	PERCENT OVERHANGING VEGETATION	POOL QUALITY RATING	PERCENT COBBLE EMBEDDEDNESS	RIFFLE SUBSTRATE COMPOSITION (%) BR	80	RU	CO	GR	FI
OROFINO CR.	0.0-5.1	20	4	2	8	0	22	42	23	8	5
	5.1-8.3	20	1		5	5	30	35	25	4	1
	8.3-15.4	6	3		10	7	20	17	26	20	10
	15.4-16.8	7	1	3	15	2	1	2	45	45	5
	16.8-19.7	7	0.5	4	15	0	5	20	40	30	5
	19.7-22.6	7	0.5	4	15	0	5	20	40	30	5
	22.6-25.9	10	0.8	3	13	0	20	40	25	10	5
	25.9-29.7	15	5	3	20	5	10	35	20	15	15
	29.7-31.6	10	2	4	25	5	10	35	20	15	15
	31.6-32.9	10	1		10	10	30	35	15	7	3
	32.9-36.4	10	1		10	10	30	35	15	7	3
	36.4-38.2	5	5		20	0	10	35	25	15	15
	38.2-40.0	30	10		30	25	30	5	5	5	30
	40.0-42.4	25	2	3	25	5	25	25	10	30	5
	42.4-45.1	25	2	4	25	0	15	20	20	40	5
	45.1-46.4	20	10	1	30	2	8	15	25	25	25
	46.4-48.3	20	10	1	40	2	8	15	25	25	25
	48.3-48.9	70	50	1	45	2	3	20	30	25	20
	48.9-51.7	70	50	1	45	2	3	20	30	25	20
	51.7-55.4	75	50	3	10	2	13	20	25	20	20
	55.4-57.5	55	40	3	15	0	15	20	30	20	15
	57.5-60.2	80	7	3	15	0	5	25	35	30	10
	60.2-61.1	75	2	3	15	10	25	25	20	15	5
	61.1-62.0	75	2	3	15	10	25	25	20	15	5
	62.0-62.6	65	1	4	15	10	25	15	22	18	10
QUARTZ CREEK	0.0-3.1	60	50	2	15	5	15	20	25	20	15
	3.1-4.9	30	20	2	20	0	0	5	15	15	55
	4.9-6.4	25	20	2	75	0	5	20	20	10	45
	6.4-10.0	50	40	4	75	0	3	7	10	10	70
LITTLE BEAVER CR.	0.0-1.7	75	70	4	20	0	5	15	15	20	35
	1.7-3.3	65	70	3	25	0	0	10	20	45	25

BR = bedrock; 80 = boulder; RU = tubble; CO = cobble; GR = gravel; FI = fine sediments

TABLE A-2 Continued

STREAM	REACH (km)	PERCENT SHADE	PERCENT OVERHANGING VEGETATION	POOL QUALITY RATING	PERCENT COBBLE EMBEOOEONESS	RIFFLE SUBSTRATE COMPOSITION (%) BR	80	RU	CO	GR	FI
TRAIL CREEK	0.0-2.6	20	10	3.5	20	0	5	30	30	20	10
	2.6-3.8	85	50	2	25	0	0	3	7	60	30
TRAPPER GULCH	0.0-0.8	75	30	2	30	0	5	10	15	60	10
	0.8-2.1	75	30	2	30	0	5	10	15	60	10
CANAL GULCH	o-1.3	75	25	3	30	0	10	15	15	40	20
	1.3-1.7	80	30	4	60	0	5	10	10	20	55
	1.7-2.6	80	30	4	60	0	5	10	10	20	55
E FK CANAL GULCH	0.0-3.4	80	50	3	75	0	5	5	5	15	70
ROSEBUD CREEK	0.0-1.4	75	25	3	50	0	5	5	5	15	70
	1.4-2.3	75	25	3	50	0	5	5	5	15	70
JENSON CR.	0.0-0.2	30	15	3	90	0	0	5	5	5	85
POORMAN CREEK	0.0-1.1	90	75	2	25	0	10	35	25	15	15
	1.1-1.8	80	60	2	25	20	20	20	10	10	20
McCAULEY CR.	0.0-1.0	90	80	1	35	10	10	25	20	15	10
RHODES CREEK	0.0-1.7	80	75	4	35	0	5	20	40	15	20
	1.7-7.5	50	20	4.5	33	0	5	22	20	25	28
	7.5-8.2	65	50	4	75	0	3	7	20	20	50
	8.2-9.4	50	10	4	50	0	0	0	5	25	70

BR q bedrock; BO = boulder; RU = tubble; CO = cobble; GR = gravel; FI = fine sediments

TABLE A-2 Continued

STREAM	REACH (km)	PERCENT SHADE	PERCENT OVERHANGING VEGETATION	POOL QUALITY RATING	PERCENT COBBLE EMBEDDEDNESS	RIFFLE SUBSTRATE COMPOSITION (%) BR	80	RU	CO	GR	FI
CLEARWATER GULCH	0.0-0.3	95	70	1	80	0	5	20	5	5	65
SHANGHAI CR.	0.0-3.2	75	60	3	75	1	4	5	5	5	80
COW CREEK	0.0-2.8	95	35	3	5	0	25	40	25	5	5
HILDEBRAND CREEK	0.0-0.3	70	50	2	50	10	15	15	15	10	35
CEDAR CREEK	0.0-0.2	90	35	3	5	5	80	15	2	2	1
RUOO CREEK	0.0-0.1	100	100	2	25	0	15	35	20	20	10
MUTTON GULCH	0.0-0.8	60	25	2	50	0	5	5	5	10	75
ST. LOUIS CREEK	0.0-0.2	90	90	1	75	0	0	0	0	20	80
ARMSTRONG CREEK	0.0-0.4	90	30	1	50	0	0	0	5	10	85
RESCUE CREEK	0.0-0.1	75	15	2	30	5	5	5	15	60	10

BR = bedrock; 80 = boulder; RU = tubble; CO = cobble; GR = gravel; FI = fine sediments

TABLE A-3. STRUCTURAL MIGRATION BARRIERS IN STREAMS OF THE OROFINO CREEK DRAINAGE, IDAHO, 1987.

STREAM	LOCATION 1 (Km)	TYPE 2	HEIGHT 3 (m)	BARRIER SEVERITY 4 CHINOOK	/ STEELHEAD
OROFINO CREEK	8.3	F	25.3	1	1
	32.9	F	4.0	1	1
	33.5	F	2.1	3	3
	38.1	F	1.8	3	
	39.3	C	1.8	2	33
	52.9	80	1.5	1	3
	56.5	LWOIF	2.0	2	3
	56.8	LWD/F	1.2	3	3
	57.1	LWD/F	1.2		3
	57.3	LWOIF	1.2	2	3
	57.9	LWD/F	3.0	1	1
	57.9	LWD/F	1.1	3	4
	58.0	LWOIF	0.9	3	4
	58.1	LWD/F	0.9	3	4
	58.2	LWD/F	1.1	2	4
	58.6	LWOIF	1.1	3	4
	59.2	LWD/F	1.2	3	
	59.5	LWD/F	1.1	3	44
	59.8	LWOIF	1.4	3	4
	60.0	LWOIF	0.9	3	4
	60.1	LWD/F	1.7	2	3
	61.2	LWD/F	0.7	3	4
	61.4	LWD/F	1.1	3	4
	61.5	C	0.9	1	4
	61.6	BS	22.8 (10%)	2	3
	62.1	C	1.5	2	3
	62.1	LWD/F	0.8	2	4
	62.2	LWOIF	0.9	3	4
	62.2	LWD/F	1.2	3	4
	62.3	LWD/F	1.2	1	3
	62.3	C	1.5	1	3
	62.4	LWD/F	1.8	1	3
	62.5	LWOIF	0.9	2	4
	62.6	BS	0.9	3	4
	62.6	F	2.3	1	1

TABLE A-3 Continued

STREAM	LOCATION [1] (Km)	TYPE [2]	HEIGHT [3] (m)	BARRIER SEVERITY [4] CHINOOK	/ STEELHEAO
QUARTZ CREEK	4.7	Jaype Log Pond Dam	2.5	1	1
LITTLE BEAVER CREEK	1.7	LWO		1	3
	2.1	80	0.9	1	3
	2.3	LWO		1	3
	3.1	LWD		1	3
	3.4	LWD		1	3
	3.6	C	12.2 (20%)	1	1
TRAIL CREEK	0.3	LWD	0.9	1	3
	2.4				
	3.6	BD	0.9 0.9	2 1	4 2
	3.8	80	1.8	1	1
TRAPPER GULCH	0.1	LWD/F	1.5	1	3
	0.3	F	1.5	1	3
	0.3	LWD/F	1.1	1	3
	0.4	LWD/F	2.	1	2
	0.5	C	1.1	1	3
CANAL GULCH	0.8	CL	9.1 (2%)	1	3
	0.9	CL	15.2 (2%)	2	4
					1
	1.3 1.6	BD Dam	2.2 1.4	1	3
	1.8	BD	0.8	1	3
	2.5	LWD	0.8	2	2
ROSEBUD CREEK	0.5	LWD	1.5	1	3
	1.4	LWD/BD	1.5	1	3
	2.3	LWD/C	1.5	1	3

TABLE A-3 Continued

STREAM	LOCATION 1 (Km)	TYPE 2	HEIGHT 3 (m)	BARRIER SEVERITY 4 CHINOOK	/ STEELHEAD
JENSON CREEK	0.1	BD	1.5	1	3
				1	3
	0.2	LWD	2.4	1	3
	0.2	BD	1.5	1	3
	0.2	C	(20%)	1	1
POORMAN CREEK	1.5	LWD	0.0	1	3
	1.8	ES	42.7 (6%)	1	1
McCAULEY CREEK	1.0	C	152.4 (13-25%)	1	1
RHODES CREEK	1.7	CL	12.2 (4%)	3	2
	4.0	LWD	1.1	2	4
	6.4	LWD	1.1	2	3
	6.5	LWD/BD	1.2	2	3
	6.8	LWD	1.2	1	4
	6.9-0.2	LWD/BD (Frequent)	0.9-1.2	2	3
	0.7	BD	1.1		3
	0.0	BD	1.2	2	3
	9.1	BD	1.5	2	3
	9.4	CL	1.1	2	3
	9.4		15.2 (2%)	1	1
SHANGHAI CREEK	3.2	C	2.4	1	1
COW CREEK	1.7	LWD/F	1.4	1	3
	1.9	CL	15.2 (4%)	1	I
SKINNER CREEK	0.1	Road Crossing	-	1	1

TABLE A-3 Continued

STREAM	LOCATION 1 (Km)	TYPE 2	HEIGHT 3 (m)	BARRIER SEVERITY 4 CHINOOK	/ STEELHEAD
HILDEBRAND CR.	0.3	BD/F	1.2	1	1
CEDAR CREEK	0.5	C		1	1
RUDO CREEK	0.1	F	6.1	1	1
FLAT CREEK	0.0	BD	1.4	1	1
MUTTON GULCH	0.0	C	- (20%)	1	1
RESCUE CREEK	0.0 0.1	F BS	1.1 30.0 (30%)	1 1	3 1

1 = Location is the distance in kilometers upstream from the stream's mouth.
2= F: Falls
C: Cascade
LWD: Large Woody Debris
BD: Beaver Dam
BS: Bedrock Slide
CL: Culvert
3 = Heights are given for most of the migration barriers. The length and gradient (in parentheses) are given for cascades. culverts. and bedrock slides.
4= 1: Definite Barrier -
2: Probable Barrier
3: Potential Barrier (if conditions change)
4: No Barrier

APPENDIX B -- STREAM TEMPERATURE DATA

TableB-l. Stream temperatures recorded by thermographs at five stations in the Orofino Creek drainage, 1987.

Station	Week Ending	Mean Temperture (C) Weekly	Minimum	Maximum	Range (C) Minimum	Maximum
Orofino Creek	7/16	21.0	18.0	24.5	16.5-20.5	19.0-28.5
at Orofino	7/23	19.0	17.0	21.5	14.5-18.5	18.5-24.5
(SK 0.0)	7/30	23.5	20.0	27.0	18.5-21.0	25.5-28.5
	8/06	20.5	17.5	24.5	15.5-20.0	23.0-25.0
	8/13	20.5	18.5	24.0	16.5-20.0	19.5-27.5
	8/20	18.5	15.5	21.5	14.5-17.0	19.5-23.0
	8/27	19.0	16.0	22.0	15.0-17.0	20.0-23.0
	9/03	20.0	17.0	23.5	16.0-18.0	23.0-24.0
Orofino Creek	7/16	20.0	16.5	24.5	14.5-18.5	19.5-28.5
below Rudo	7/23	17.5	15.0	20.5	13.0-16.5	16.5-24.0
(SK19.7)	7/30	22.5	18.5	27.0	16.5-19.5	25.5-28.5
	8/06	20.0	15.5	24.5	14-0-18.5	22.5-26.0
	8/13	20.0	16.0	24.0	14.5-18.0	19.5-27.5
	8/20	17.0	14.0	21.0	12.5-16.5	17.5-22.5
	8/27	18.0	14.5	21.0	13.5-15.5	19.0-22.0
	9/03	19.0	15.0	22.5	14.5-16.5	22.0-23.0
Orofino Creek	7/16	18.5	15.5	21.0	13.5-18.0	18.5-23.5
at Poorman	7/23	16.5	14.5	18.5	12.5-16.0	15.5-20.0
(SK 36.4)	7/30	21.0	18.0	23.0	15.5-19.5	22.0-24.0
	8/06	18.5	16.0	20.5	14.0-18.5	19.5-21.5
	8/13	18.5	16.5	20.5	15.0-18.5	17.5-23.0
	8/20	16.0	14.0	18.0	12.5-16.0	16.5-19.0
	8/27	16.5	14.5	18.0	14.0-15.5	16.5-18.5
	9/03	17.5	15.5	19.5	14.5-16.5	18.5-20.0
Orofino Creek	7/16	14.5	11.5	17.0	10.0-13.0	13.5-19.5
at FS Boundary	7/23	12.5	11.0	14.5	10.0-12.0	12.0-16.5
(SK53.1)	7/30	15.5	13.0	19.0	10.5-14.0	18.0-19.5
	8/06	14.0	10.5	17.5	10.0-10.5	17-0-18.5
	8/13	14.5	11.5	17.5	10.5-13.0	14.5-20.0
	8/20	12.5	10.5	15.0	9.5-12.5	12.5-16.5
	8/27	13.0	10.5	15.5	10.0-11.5	14.5-16.5
	9/03	13.5	11.0	17.0	10.5-12.0	16.0-17.5
RhodesCreek	7/16	17.5	15.0	21.0	13.0-17.0	17.0-24.0
(SK1.7)	7/23	15.5	13.5	17.5	12.0-15.0	14.5-19.5
	7/30	20.0	17.0	23.0	15.0-18.0	22.0-24.5
	8/06	18.0	14.5	21.0	13.5-15.5	20.0-22.0
	8/13	17.5	15.0	20.5	14-0-16.5	17.0-23-0
	8/20	15.0	13.0	17.5	11.0-15.0	15.0-19.5
	8/27	15.5	13.5	18.5	13.0-14.5	17.0-19.0
	9/03	16.0	13.0	19.5	12-0-13.5	18.5-20.0

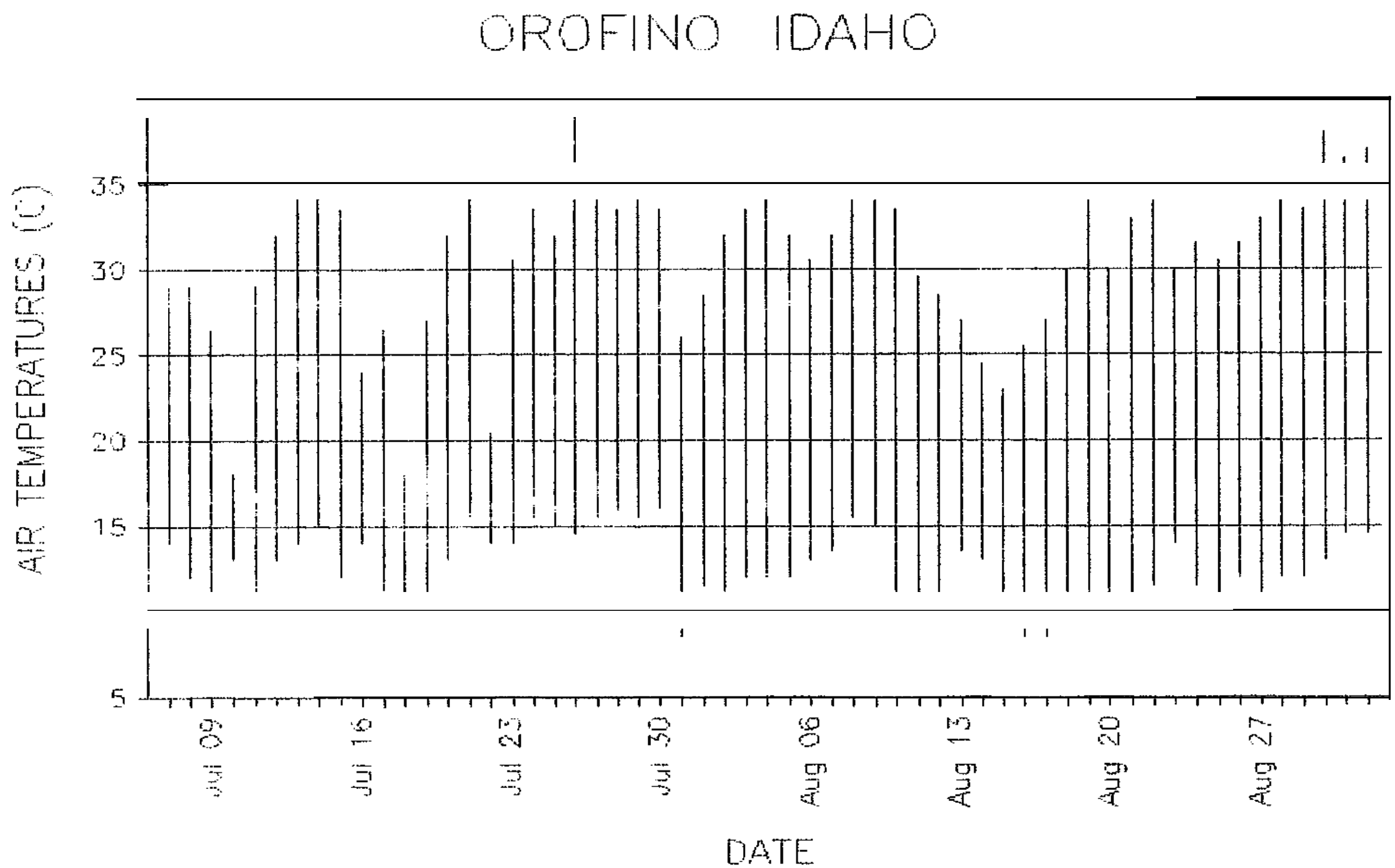

Figure B-1. Air temperatures recorded at Orofino, Idaho during summer 1987 (source: local newspaper).

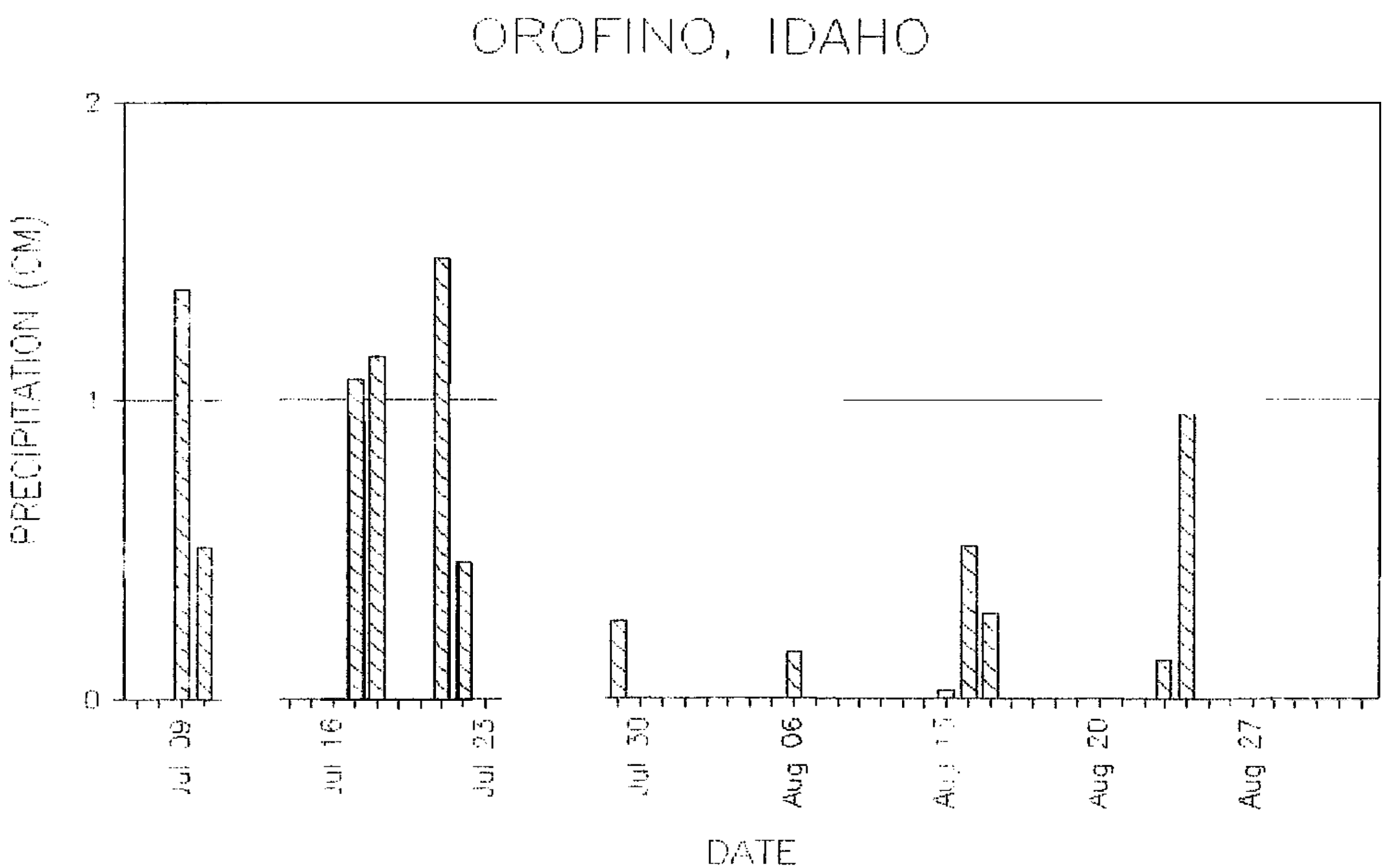

Figure B-2. Precipitation recorded at Orofino, Idaho summer 1987 (source: local newspaper).

APPENDIX C -- RESIDENT FISH DATA

Table C-1. Densities of trout in specific habitat types within seven strata of streams in the Orofino Creek drainage, summer 1987.

Stream/Strata/Habitat Type	Number Sampled	Number of Trout Per 100 Square Meters							
		Rainbow Trout				Brook Trout			
		Age 0+		Overyearling		Age 0+		Overyearling	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Orofino Creek									
Below Orofino Falls									
Pools	6	0.00	0.00-0.00	0.05	0.00-0.28	0.00	0.00-0.00	0.00	0.00-0.00
Riffles	2	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Runs	4	0.00	0.00-0.00	0.31	0.00-1.23	0.00	0.00-0.00	0.00	0.00-0.00
Pocketwaters	3	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Glides	3	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Sidechannels	1	18.64	18.64	3.11	3.11	0.00	0.00	0.00	0.00
Backwaters	4	3.45	0.00-13.79	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Orofino Falls-Lightning Cr.									
Pools	11	0.72	0.00-5.27	0.37	0.00-1.82	0.00	0.00-0.00	0.08	0.00-0.91
Riffles	5	0.12	0.00-0.58	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Runs	2	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Pocketwaters	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glides	3	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Sidechannels	2	1.11	0.00-2.21	0.00	0.00-0.00	0.00	0.00-0.00	0.56	0.00-1.11
Backwaters	3	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Lightning Cr.-Upper Falls									
Pools	13	0.41	0.00-3.26	2.17	0.00-9.10	0.00	0.00-0.00	0.32	0.00-2.48
Riffles	4	2.23	0.00-8.92	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Runs	5	0.70	0.00-2.64	0.68	0.00-2.90	0.00	0.00-0.00	0.00	0.00-0.00
Pocketwaters	4	6.81	0.00-12.47	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Backwaters	4	0.37	0.00-1.46	0.00	0.00-0.00	0.37	0.00-1.46	0.00	0.00-0.00

Table C-1 (cont.). Densities of trout in specific habitat types within seven strata of streams in the Orofino Creek drainage, summer 1987.

		Number of Trout Per 100 Square Met							
		Rainbow Trout				Brook Trout			
	Number	Age 0+		Overyearling		Age 0+		Overyearling	
Stream/Strata/Habitat Type	Sampled	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Orofino Creek									
Upper Falls-Pierce									
Pools	10	0.16	0.00-1.28	2.14	0.00-5.62	0.00	0.00-0.00	0.16	0.00-1.56
Riffles	3	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Runs	5	0.38	0.00-1.89	2.08	0.00-3.78	0.00	0.00-0.00	0.00	0.00-0.00
Pocketwaters	5	0.74	0.00-1.54	1.20	0.00-5.12	0.00	0.00-0.00	0.00	0.00-0.00
Glides	3	0.30	0.00-0.89	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Backwaters	3	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.00
Above Pierce									
Pools	5	13.05	4.29-24.71	7.69	4.29-19.89	19.90	0.00-75.12	9.56	2.47-25.12
Riffles	4	6.80	6.05-8.34	0.92	0.00-3.27	9.25	0.00-31.78	0.92	0.00-3.27
Runs	2	20.14	13.23-27.04	5.69	4.77-6.61	3.98	0.00-7.95	1.59	0.00-3.18
Pocketwaters	2	3.59	0.00-7.17	4.98	2.87-7.08	0.72	0.00-1.43	3.54	0.00-7.08
Glides	1	1.39	1.39	0.00	0.00	24.93	24.93	1.39	1.39
Sidechannels	2	11.70	0.00-23.39	0.00	0.00-0.00	17.55	0.00-23.39	0.00	0.00-0.00
Lower Tributaries									
Pools	10	7.90	0.00-18.05	15.38	0.00-79.37	2.69	0.00-12.15	2.30	0.00-12.15
Riffles	5	6.31	0.00-17.82	0.00	0.00-0.00	0.00	0.00-0.00	0.31	0.00-1.53
Pocketwaters	1	6.00	6.00	4.00	4.00	0.00	0.00	2.00	2.00
Upper Tributaries									
Pools (excluding ponds)	9	3.50	0.00-17.73	1.39	0.00-3.99	22.91	0.00-100.81	18.15	1.58-56.73
Ponds	4	1.68	0.00-4.34	0.03	0.00-0.10	50.27	3.57-162.13	25.03	6.28-60.79
Riffles	4	8.75	4.36-15.11	0.00	0.00-0.00	26.88	4.65-46.56	2.42	0.00-9.67
Runs	4	11.78	0.00-27.70	6.23	0.00-22.16	46.87	22.16-69.29	6.34	0.00-13.85
Pocketwaters	2	0.00	0.00-0.00	1.31	0.00-2.61	39.46	18.25-60.66	5.35	2.61-8.08
Glides	2	12.21	11.23-13.18	2.20	0.00-4.39	89.95	39.30-140.60	23.80	16.84-30.75
Sidechannels	3	14.07	5.92-26.93	0.00	0.00-0.00	128.09	39.06-179.53	11.06	0.00-26.92
Backwaters	1	0.00	0.00	0.00	0.00	0.00	0.00	12.79	12.79

Table C-2. Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Orofino Cr. at Konkolville										
1. run	s	rb	109.16	34.86	0.00	0.00	0.00	0.00	0.00	0.00
2. boulder pool	s	rcb	186.76	53.96	0.00	0.00	0.00	0.00	0.00	0.00
3. pocketwater	s	br	99.22	20.86	0.00	0.00	0.00	0.00	0.00	0.00
4. debris pool	s	rcb	71.91	28.69	0.00	0.00	0.00	0.00	0.00	0.00
5. glide	s	brc	337.24	73.98	0.00	0.00	0.00	0.00	0.00	0.00
6. pool	s	rcb	165.12	46.94	0.00	0.00	0.00	0.00	0.00	0.00
7. riffle	s	rbc	125.94	25.70	0.00	0.00	0.00	0.00	0.00	0.00
8. meander pool	s	crb	276.48	93.43	0.00	0.00	0.00	0.00	0.00	0.00
9. riffle	s	cgr	149.75	30.72	0.00	0.00	0.00	0.00	0.00	0.00
10. glide	s	brc	202.06	46.00	0.00	0.00	0.00	0.00	0.00	0.00
11. run	s	rb	51.43	13.58	0.00	0.00	0.00	0.00	0.00	0.00
12. pocketwater	s	brc	95.43	23.37	0.00	0.00	0.00	0.00	0.00	0.00
13. bedrock pool	s	rcb	357.49	160.92	0.00	0.00	0.28	0.00	0.00	0.00
Orofino Cr. below Orofino Falls										
14. run	s	br	81.23	21.76	0.00	1.23	0.00	0.00	0.00	0.00
15. backwater	s	rb	12.26	2.08	0.00	0.00	0.00	0.00	0.00	0.00
16. pocketwater	s	br	104.24	26.03	0.00	0.00	0.00	0.00	0.00	0.00
17. run	s	br	37.72	9.78	0.00	0.00	0.00	0.00	0.00	0.00
18. boulder pool	s	br	156.39	57.28	0.00	0.00	0.00	0.00	0.00	0.00
19. glide	s	br	195.31	47.36	0.00	0.00	0.00	0.00	0.00	0.00
20. sidechannel	e	br	32.19	2.15	18.64	3.11	0.00	0.00	0.00	0.00
21. backwater	e	cr	3.25	0.17	0.00	0.00	0.00	0.00	0.00	0.00
22. backwater	e	cr	4.02	0.37	0.00	0.00	0.00	0.00	0.00	0.00
23. backwater	e	r	7.25	0.78	13.79	0.00	0.00	0.00	0.00	0.00

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Salmonid Densities (number/100 sq m) Rainbow Trout Age 0+	Rainbow Trout Age 1+	Rainbow Trout Age >2	Brook Trout Age 0+	Brook Trout Age 1+	Brook Trout Age >2
Orofino Cr. near Cedar Cr.										
24. bedrock pool	s	-	632.29	598.24	0.00	0.00	0.00	0.00	0.00	0.00
25. backwater	s	gm	63.89	16.32	0.00	0.00	0.00	0.00	0.00	0.00
26. meander pool	s	cgr	210.70	65.69	0.00	0.00	0.00	0.00	0.00	0.00
27. glide	s	cgr	131.77	18.15	0.00	0.00	0.00	0.00	0.00	0.00
28. bridge pool	s	crg	273.91	160.55	0.00	0.37	0.00	0.00	0.00	0.00
29. riffle	s	cr	49.36	6.58	0.00	0.00	0.00	0.00	0.00	0.00
30. backwater	s	gm	19.73	3.44	0.00	0.00	0.00	0.00	0.00	0.00
31. glide	s	crg	147.30	23.35	0.00	0.00	0.00	0.00	0.00	0.00
32. bedrock pool	s	cgm	554.75	359.51	0.00	0.18	0.18	0.00	0.00	0.00
33. meander pool	s	gcm	118.37	25.53	2.53	0.00	0.00	0.00	0.00	0.00
34. boulder pool	s	brg	36.82	8.40	0.00	0.00	0.00	0.00	0.00	0.00
35. bedrock pool	s	cgm	113.76	53.24	5.27	0.00	0.00	0.00	0.00	0.00
36. riffle	s	crg	172.83	28.60	0.58	0.00	0.00	0.00	0.00	0.00
37. meander pool	s	crg	122.48	33.76	0.00	0.00	0.00	0.00	0.00	0.00
38. pool	s	mg	1415.15	622.36	0.07	0.00	0.00	0.00	0.00	0.00
39. run	s	rc	42.41	10.37	0.00	0.00	0.00	0.00	0.00	0.00
40. riffle	e	gc	157.81	13.27	0.00	0.00	0.00	0.00	0.00	0.00
Orofino Cr. near Lime Mt.										
41. pocketwater	e	br	155.52	31.75	0.00	0.00	0.00	0.00	0.00	0.00
42. sidechannel	e	cr	154.56	16.98	0.00	0.00	0.00	0.00	0.00	0.00
43. backwater	e	cm	37.81	1.85	0.00	0.00	0.00	0.00	0.00	0.00
44. glide	e	crg	208.47	31.15	0.00	0.00	0.00	0.00	0.00	0.00

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Orofino Cr. at Rudo										
45. meander pool	e	rc	131.92	33.52	0.00	0.00	1.52	0.00	0.00	0.00
46. sidechannel	e	gcs	90.39	10.04	2.21	0.00	0.00	0.00	1.11	0.00
47. riffle	e	rc	158.68	22.04	0.00	0.00	0.00	0.00	0.00	0.00
48. riffle	e	rc	491.64	64.80	0.00	0.00	0.00	0.00	0.00	0.00
49. run	e	rc	65.26	8.59	0.00	0.00	0.00	0.00	0.00	0.00
50. bedrock pool	e	rb	109.69	31.55	0.00	0.00	1.82	0.00	0.00	0.91
Orofino Cr. near Lightning Cr.										
51. backwater	e	mr	68.31	9.05	1.46	0.00	0.00	1.46	0.00	0.00
52. boulder pool	e	rb	35.12	10.21	0.00	0.00	2.85	0.00	0.00	0.00
53. backwater	e	ms	9.54	1.19	0.00	0.00	0.00	0.00	0.00	0.00
54. run	e	rcb	195.84	51,64	0.00	0.00	0.51	0.00	0.00	0.00
55. riffle	e	rc	202.99	21.22	0.00	0.00	0.00	0.00	0.00	0.00
56. pool	e	cr	21.76	3.83	0.00	0.00	0.00	0.00	0.00	0.00
57. pocketwater	e	rb	179.28	28.58	0.00	0.00	0.00	0.00	0.00	0.00
58. run	s	br	105.27	28.25	0.00	0.00	0.00	0.00	0.00	0.00
59. boulder pool	s	br	40.79	15.35	0.00	0.00	0.00	0.00	0.00	0.00
60. boulder pool	s	br	40.33	17.11	0.00	0.00	2.48	0.00	0.00	2.48

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Orofino Cr below Cow Cr.										
61. bedrock pool	s	crb	275.76	151.21	0.73	1.45	0.00	0.00	0.00	0.00
62. riffle	s	br	33.62	5.27	8.92	0.00	0.00	0.00	0.00	0.00
63. pocketwater	s	br	48.12	8.65	12.47	0.00	0.00	0.00	0.00	0.00
64. bridge pool	s	br	184.32	94.55	3.26	5.97	0.00	0.00	1.09	0.00
65. pocketwater	s	br	108.39	18.07	12.92	0.00	0.00	0.00	0.00	0.00
66. run	s	br	37.94	10.09	2.64	0.00	0.00	0.00	0.00	0.00
67. boulder pool	s	br	76.92	35.71	0.00	2.60	6.50	0.00	0.00	0.00
68. backwater	s	bs	12.70	2.24	0.00	0.00	0.00	0.00	0.00	0.00
69. bedrock pool	s	brs	169.87	134.35	0.00	1.77	1.77	0.00	0.00	0.59
70. backwater	s	rcb	63.87	14.24	0.00	0.00	0.00	0.00	0.00	0.00
71. riffle	s	brc	41.11	9.20	0.00	0.00	0.00	0.00	0.00	0.00
72. run	s	br	115.82	29.06	0.86	0.00	0.00	0.00	0.00	0.00
73. run	s	rb	137.82	42.38	0.00	0.00	2.90	0.00	0.00	0.00
74. boulder pool	s	br	72.39	19.52	1.38	0.00	0.00	0.00	0.00	0.00
75. boulder pool	s		54.81	18.44	0.00	0.00	5.47	0.00	0.00	0.00
76. boulder pool	s	brs	182.40	74.79	0.00	0.00	0.00	0.00	0.00	0.00
77. boulder pool	s	bcs	56.86	23.30	0.00	0.00	1.76	0.00	0.00	0.00
78. bedrock pool	s	rs	75.81	30.76	0.00	0.00	0.00	0.00	0.00	0.00
79. pocketwater	s	rc	54.52	10.05	1.83	0.00	0.00	0.00	0.00	0.00
80. riffle	s	crg	38.50	5.17	0.00	0.00	0.00	0.00	0.00	0.00

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Salmonid Densities (number/100 sq m) Rainbow Trout Age 0+	Rainbow Trout Age 1+	Rainbow Trout Age >2	Brook Trout Age 0+	Brook Trout Age 1+	Brook Trout Age >2
Orofino Creek at Poorman										
81. debris pool	s	rbg	35.54	14.72	0.00	2.81	2.81	0.00	0.00	0.00
82. pocketwater	s	b	278.99	74.90	0.36	0.00	0.36	0.00	0.00	0.00
83. backwater	s	r	11.15	1.95	0.00	0.00	0.00	0.00	0.00	0.00
84. pocketwater	s	rb	191.75	39.55	0.52	0.00	0.52	0.00	0.00	0.00
85. run	s	rg	32.78	7.90	0.00	0.00	0.00	0.00	0.00	0.00
86. pocketwater	s	bgr	38.59	8.15	0.00	0.00	0.00	0.00	0.00	0.00
87. debris pool	s	br	39.02	13.88	0.00	2.56	2.56	0.00	0.00	0.00
88. run	s	rcb	52.80	11.23	1.89	1.89	1.89	0.00	0.00	0.00
89. glide	s	rb	270.35	65.72	0.00	0.00	0.00	0.00	0.00	0.00
90. run	s	rb	238.45	49.33	0.00	0.00	0.00	0.00	0.00	0.00
91. backwater	s	scg	37.41	5.83	0.00	0.00	0.00	0.00	0.00	0.00
92. glide	s	gcr	334.82	73.22	0.00	0.00	0.00	0.00	0.00	0.00
93. bedrock pool	s	brg	230.77	69.46	0.00	0.43	0.00	0.00	0.00	0.00
94. riffle	s	rc	38.15	7.59	0.00	0.00	0.00	0.00	0.00	0.00
Orofino Cr. above Poorman										
95. boulder pool	s	cg	154.28	56.73	0.00	0.00	1.30	0.00	0.00	0.00
96. riffle	s	g	97.55	13.90	0.00	0.00	0.00	0.00	0.00	0.00
97. meander pool	s	sg	373.28	154.68	0.00	0.00	0.00	0.00	0.00	0.00
98. meander pool	s	sg	359.72	225.03	0.00	0.00	0.28	0.00	0.00	0.00
99. meander pool	s	sg	241.55	159.82	0.00	0.00	0.00	0.00	0.00	0.00
100. pocketwater	s	bg	78.13	25.43	1.28	0.00	5.12	0.00	0.00	0.00
101. pocketwater	s	bg	65.03	11.38	1.54	0.00	0.00	0.00	0.00	0.00
102. bedrock pool	s	bs	144.77	92.45	0.00	0.69	0.69	0.00	0.00	0.00
103. boulder pool	s	bs	78.04	31.33	1.28	0.00	3.84	0.00	0.00	0.00

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
					Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Orofino Cr. near Flat Cr.										
104. backwater	e	m	26.32	2.78	0.00	0.00	0.00	0.00	0.00	0.00
105. run	s	c	63.07	8.65	0.00	0.00	3.17	0.00	0.00	0.00
106. riffle	e	g	59.00	6.08	0.00	0.00	0.00	0.00	0.00	0.00
107. glide	e	cg	111.90	17.90	0.89	0.00	0.00	0.00	0.00	0.00
108. run	s	cg	86.96	19.98	0.00	0.00	3.45	0.00	0.00	0.00
109. meander pool	s	cr	320.24	98.74	0.31	0.94	2.50	0.00	1.25	0.31
Orofino Cr. near Pierce										
110. riffle	e	crg	95.92	13.81	8.34	0.00	0.00	5.21	0.00	0.00
Orofino Creek near Cardiff										
111. riffle	e	gc	239.14	15.65	6.27	0.42	0.00	31.78	0.42	0.00
112. glide	e	cs	144.38	23.84	1.39	0.00	0.00	24.93	1.39	0.00
113. meander pool	s	gs	95.53	35.45	16.75	18.84	1.05	11.51	18.84	6.28
114. meander pool	s	gs	101.17	27.67	24.71	1.98	1.98	75.12	8.90	1.98

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Orofino Cr. below Rosebud Cr.										
115. debris pool	e	gcr	46.66	9.74	4.29	4.29	0.00	12.86	2.14	0.00
116. sidechannel	e	gs	10.94	0.56	0.00	0.00	0.00	0.00	0.00	0.00
117. pocketwater	e	brc	69.71	7.53	7.17	2.87	0.00	1.43	0.00	0.00
118. meander pool	e	cgr	55.64	11.59	7.19	5.39	0.00	0.00	3.59	3.59
119. riffle	e	cgr	30.56	3.04	6.54	3.27	0.00	0.00	0.00	3.27
120. run	e	rcb	62.88	9.14	27.04	3.18	1.59	7.95	3.18	0.00
Orofino Cr. near Trib C										
121. run	e	rcs	15.12	2.24	13.23	6.61	0.00	0.00	0.00	0.00
122. riffle	e	grc	33.04	1.87	6.05	0.00	0.00	0.00	0.00	0.00
123. pocketwater	e	rb	14.13	1.28	0.00	7.08	0.00	0.00	7.08	0.00
124. sidechannel	e	gs	8.55	0.27	23.39	0.00	0.00	35.09	0.00	0.00
125. debris pool	e	cr	40.55	5.21	12.33	4.93	0.00	0.00	2.47	0.00
Cow Cr. (lower)										
126. boulder pool	e	rc	8.18	0.83	12.22	36.67	0.00	0.00	0.00	0.00
127. boulder pool	e	rc	25.92	4.09	7.72	3.86	0.00	0.00	0.00	0.00
128. boulder pool	e	rc	1.26	0.12	0.00	0.00	79.37	0.00	0.00	0.00
129. boulder pool	e	rc	8.13	0.75	0.00	12.30	0.00	0.00	0.00	0.00
130. riffle	e	rc	22.45	0.91	17.82	0.00	0.00	0.00	0.00	0.00
131. boulder pool	e	rc	10.99	1.00	0.00	0.00	0.00	0.00	0.00	0.00
132. riffle	e	rc	3.22	0.14	0.00	0.00	0.00	0.00	0.00	0.00
133. riffle	e	rc	3.41	0.17	0.00	0.00	0.00	0.00	0.00	0.00

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Poorman Cr. (lower)										
134. boulder pool	e	bc	18.47	2.35	0.00	0.00	0.00	0.00	0.00	0.00
135. riffle	e	rc	21.87	1.36	9.14	0.00	0.00	0.00	0.00	0.00
136. boulder pool	e	bc	17.85	1.98	11.20	0.00	0.00	5.60	0.00	0.00
137. debris pool	e	rs	18.12	1.77	5.52	5.52	0.00	5.52	0.00	0.00
138. pool	e	c	8.23	0.98	24.30	12.15	0.00	12.15	12.15	0.00
Quartz Cr. near Threemile Cr.										
139. riffle	e	rb	65.40	6.97	4.59	0.00	0.00	0.00	0.00	1.53
140. pocketwater	e	br	50.04	5.13	6.00	4.00	0.00	0.00	0.00	2.00
141. boulder pool	e	bs	27.70	4.50	18.05	0.00	3.61	0.00	3.61	10.83
Quartz Cr. below Trail Cr.										
142. riffle	e	gc	86.03	6.79	15.11	0.00	0.00	4.65	0.00	0.00
143. backwater	e	s	15.64	2.59	0.00	0.00	0.00	0.00	12.79	0.00
144. sidechannel	e	s	64.01	7.87	9.37	0.00	0.00	39.06	6.25	0.00
145. dredge pool	s	sm	80.02	39.44	1.25	3.74	0.00	0.00	4.99	3.74
146. beaver pond	s	ms	84.05	39.95	2.37	0.00	0.00	3.57	0.00	9.52

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Trail Cr. below L. Beaver Cr.										
147. dredge pool	s	mr	121.98	32.00	5.74	0.82	0.00	16.40	18.04	13.12
148. dredge pool	s	ms	175.43	128.97	1.71	1.14	2.85	2.85	3.99	14.82
149. run	e	cgr	18.05	1.81	27.70	22.16	0.00	22.16	0.00	0.00
L. Beaver Cr. below Trapper Cr.										
150. meander pool	e	g	28.20	3.06	17.73	3.55	0.00	46.10	42.55	14.18
151. riffle	e	g	10.34	0.43	9.67	0.00	0.00	38.68	9.67	0.00
152. run	e	gb	8.69	0.81	0.00	0.00	0.00	46.03	11.51	0.00
153. glide	e	gs	22.76	3.67	13.18	4.39	0.00	140.60	26.36	4.39
154. debris pool	e	gs	19.84	1.60	5.04	0.00	0.00	100.81	40.32	0.00
155. sidechannel	e	sg	11.14	0.63	26.93	0.00	0.00	179.53	26.92	0.00
L. Beaver Cr. above Trapper Cr.										
156. beaver pond	s	sm	184.26	56.22	4.34	0.00	0.00	27.68	43.42	17.37

Table C-2 (cont.). Stream habitat and salmonid density data collected at 23 locations and 170 individual habitat elements in streams within the Orofino Creek drainage, 1987.

					Salmonid Densities (number/100 sq m)					
					Rainbow Trout			Brook Trout		
Location/Habitat Type	Sampling Method	Substrate	Area (sq m)	Volume (cu m)	Age 0+	Age 1+	Age >2	Age 0+	Age 1+	Age >2
Rhodes Cr. (lower)										
157. dredge pool	s	msg	447.91	197.63	0.00	0.00	0.22	1.22	2.46	0.45
158. dredge pool	s	msg	651.23	257.44	0.00	0.15	0.00	5.53	1.38	1.69
159. dredge pool	s	msc	367.20	170.71	0.27	0.00	0.27	8.17	1.63	0.82
160. pool	s	gsc	63.17	12.33	0.00	0.00	0.00	33.24	1.58	0.00
161. beaver pond	s	ms	975.85	419.41	0.00	0.10	0.00	7.69	1.23	6.05
162. riffle	e	rc	68.73	5.88	4.36	0.00	0.00	46.56	0.00	0.00
163. pocketwater	e	r	38.35	2.76	0.00	0.00	2.61	18.25	2.61	0.00
164. run	e	gr	60.00	7.95	0.00	0.00	0.00	50.00	0.00	0.00
Rhodes Cr. (upper)										
165. glide	e	cs	17.81	2.36	11.23	0.00	0.00	39.30	5.61	11.23
166. beaver pond	e	ms	38.24	9.73	0.00	0.00	0.00	162.13	18.31	5.23
167. run	e	gcs	36.08	3.59	19.40	2.77	0.00	69.29	5.54	8.31
168. riffle	e	gs	17.03	0.86	5.87	0.00	0.00	17.62	0.00	0.00
169. pocketwater	e	bsr	24.73	3.24	0.00	0.00	0.00	60.66	4.04	4.04
170. sidechannel	e	ms	16.90	1.67	5.92	0.00	0.00	165.68	0.00	0.00

sampling methods: snorkel census (s), electrofishing (e).
substrate types: muck (m), sand (s), gravel (g), cobble (c), rubble (r), boulder (b).

OROFINO CREEK PASSAGE PROJECT

PART I I: FEASIBILITY AND PLAN REPORT

ACKNOWLEDGEMENTS

This Feasibility Plan Report is the result of the combined efforts of a professional team. Seton. Johnson 6 Odell. Inc. gratefully acknowledges the contributions of project team members:

Burt Carnegie - Senior Fisheries Engineer

Charles W. Huntington - Aquatic Biologist
Clearwater BioStudies, Inc.

David J. Newton - Geological Engineer
David J. Newton & Associates. Inc.

Dr. Ted Bjornn - Idaho Fisheries Specialist

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ABSTRACT

The following report reviews the cost/benefits of constructing passage facilities and/or implementing other programs to enhance anadromous salmonid production in Orofino Creek, Idaho. Orofino Creek, a tributary to the Clearwater River, currently provides minimal steelhead production downstream of Orofino Falls, an impassable barrier. In addition to Orofino Falls, two other upstream barriers were investigated.

The following four project options were analyzed for passage.

1. Passage facilities at the two upstream falls with the following options for passage at Orofino Falls:

    A. Construction of instream concrete barriers blasted modifications at the steepest upstream portion of Orofino Falls and a short prefabricated ladder.

    B. A pathway blasted into the exposed basalt cliff on the south bank into which a prefabricated fish ladder is installed.

2. Trap and Haul from the site of the proposed Clearwater Hydro Power Generating plant.

3. Hatchery outplanting on a continuous basis without any passage enhancement.

Total present value costs for each of the options are shown below and in Table 1.

1. Orofino Falls		
	A. Instream modifications	$1.354.000
	B. Fishway on south bank	$1.465.000
2. Trap & Haul		$1.407.000
3. Hatchery Outplanting		$ 240,000

Table 1

Summary of Options
Orofino Creek Passage Project

Option	Estimated Present Value Cost	Construction Period/Time	Comments
1A. Falls modification and ladder near top with upstream facilities.	$1.354.000	June to October Two summers required.	Streamflow critical - minimum flow of 140 cfs required during passage time period. May limit power production flow from February through May.
1B. Falls - Full ladder and upstream facilities	$1.465.000	June to October Two summers required.	Streamflow not critical. 30 cfs ladder and attraction flow required. Power production flow not limited.
2. Trap and Haul	$1.407.000	June to October One summer	Requires cooperation from Clearwater Hydro as facility is on their site. Cost could be lower if T & H facility is integrated with the hydro project.
3. Outplanting	$240.000	N.A. No schedule required. May be started immediately.	Outplanting requires a continual operation utilizing chinook fry obtained from existing facilities and adult steelhead returning to hatcheries. Option 4 would also eliminate the need for Clearwater Hydro to construct upstream passage at their diversion dam. It would also create a "dead end" fishery for adults at Orofino Falls. Orofino Creek would provide rearing habitate.

RECOMMENDATIONS

The Hatchery Outplanting option is recommended because its present value cost is less than 20% of the other passage options.

The estimated cost of each harvested steelhead by outplanting is also only about 6 percent of the cost of fish produced through use of the structural options. In addition to steelhead production, it also offers production of spring chinook.

Outplanting is a low cost method of measuring more accurately the productivity of the Orofino Creek drainage. Also, it does not eliminate the option of installing a passage structure if returns show that to be feasible. During this period it is also recommended that additional stream flow data be collected.

INTRODUCTION

The purpose of this Report is to document a technical analysis of the feasibility to provide anadromous fish passage throughout major portions of the Orofino Creek drainage. Orofino Creek. a tributary to Idaho's Clearwater River, has one major and two minor falls that prevent upstream migration of anadromous fish. This is a working document dealing with the general feasibility of providing fish passage. Design information contained in this report is preliminary and subject to revision during the final design process which must precede implementation of any construction alternative analyzed herein.

Designs proposed were based on information obtained from the following activities or publications:

1. Review of relevant published background information.

2. Site inspection under summer and spring flow conditions.

3. Identification of specific fish passage problem areas.

4. Identification of potential passage strategies (routes, techniques, etc.)

5. Identification of geologic, hydrologic, logistic and other physical constraints.

6. Review of available information on a proposed and licensed hydropower generating plant on lower Orofino Creek.

7. Recommendations developed during the Phase I fishery study showing steelhead to be the only species to be passed.

The following four passage options were analyzed:

1A. A combination of instream modifications with a short fish ladder at Orofino Falls and all other recommended upstream improvements.

1B. A fish ladder along the south side of Orofino Falls and all other recommended upstream improvements.

2. Trap and haul with the barrier dam required for the trap facility being the only instream structure or modification.

3. An outplanting program for the basin with no instream passage or trap and haul facilities.

All of the barriers studied and inspected are shown on Figure I.

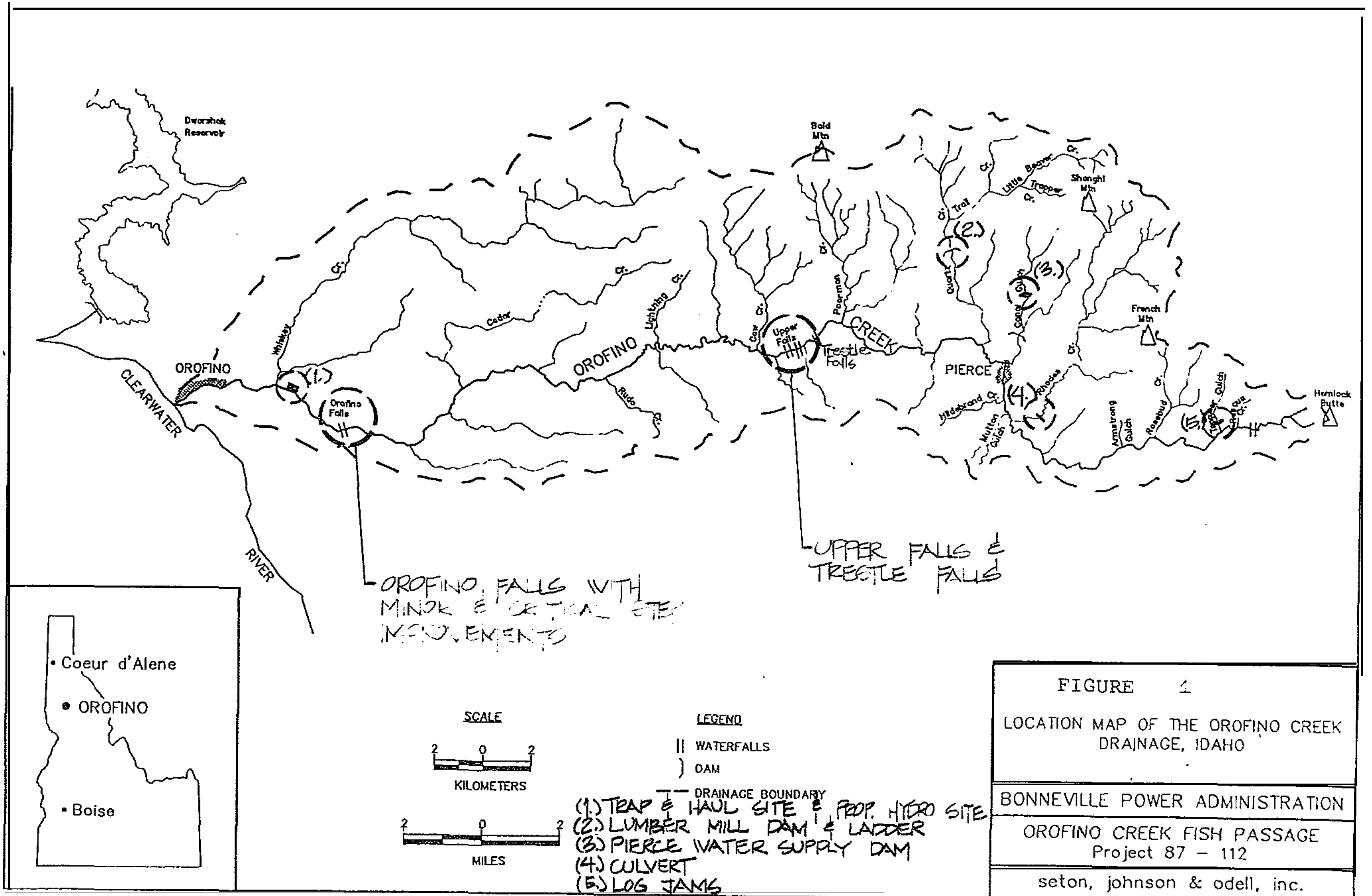

FIGURE 1

LOCATION MAP OF THE OROFINO CREEK DRAINAGE, IDAHO

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 - 112

seton, johnson & odell, inc.

The Objective of the Project

Within the framework of the Columbia Basin Fish and Wildlife Program, the Bonneville Power Administration (BPA) funds projects to mitigate anadromous fish losses caused by federal hydroelectric dams on the Columbia and Snake rivers. Sections 703(c)(l) and 1403.4.2 of the most recent Fish and Wildlife Program (Northwest Power Planning Council 1987) include a passage project for Orofino Creek, a major tributary to the lower Clearwater River, Idaho. Passage structures at the falls and other upstream barriers could allow development of self-sustaining runs of anadromous steelhead in currently inaccessible streams within the Orofino Creek drainage.

Increasing anadromous salmonid production in the lower Clearwater drainage by providing access to streams above the falls on Orofino Creek has been previously considered. In 1959, a brief investigation by the Idaho Department of Fish and Game (IDFG) indicated that passage over the falls would provide anadromous salmonid access to approximately 100 kilometers of stream (Murphy and Metsger, 1962). However, IDFG noted that low summer flows and high water temperatures might restrict production of anadromous salmonids above the falls. More recently. the U.S. Fish and Wildlife Service (USFWS) made appraisal-level estimates of the steelhead production potential of the Orofino Creek drainage above Orofino Falls (Varley and Diggs 1983). The USFWS estimates, although based on limited field data, suggested that the potential for steelhead production above the falls could be substantial. There have also been recent suggestions that habitat above the falls might be capable of supporting a self-sustaining run of spring chinook salmon.

In late June 1987. BPA initiated a two-phased study of the feasibility of providing anadromous fish passage at Orofino Falls and a second. unnamed falls on Orofino Creek. Phase I of the study. completed in January 1988, assessed the biological feasibility of establishing self-sustaining runs of anadromous salmonids above the falls. It concludes that only steelhead would find the environment of Ocof in0 Creek suitable for producing a self-sustaining fishery.

<u>The Studv Area</u>

Orofino Creek is a large, fifth-order stream and one of the major tributaries of the lower Clearwater River in northwestern Idaho (Figure 1). The stream originates on the slopes of Hemlock Butte and flows approximately 45 miles in a westerly direction, primarily through private lands, to enter the Clearwater River at the town of Orofino. The upper-most reaches of Orofino Creek and a few of its tributaries lie within the boundaries of the Clearwater National Forest. Between the town of Pierce and Orofino Falls, the stream flows through a canyon. The lower-most 3 miles of Orofino Creek flows through the Nez Perce Indian Reservation.

Orofino Creek drainage covers approximately 122,000 acres of timberland and high meadows, varying in elevation from 1.020 to 6,050 feet. Discharge near the stream's mouth is quite variable and has been estimated to range from a monthly mean of 611 cubic feet per second (cfs) in April to a mean of 30 cfs in September (Figure 2).

Anadromous fish use of the drainage is currently restricted to habitat below Orofino Falls at SM 5.2 on Orofino Creek. The falls, a total barrier to anadromous fish, is a boulder-filled cataract which drops 83 feet over a horizontal distance of 530 feet.

A second, unnamed falls (hereafter referred to as Upper Falls) at SM 20.5 drops approximately 13 feet over a 100 foot long slide like rock face. It also appears to be a barrier to upstream migration.

During the Phase I study, a third falls high enough to stop steelbead at moderate was identified at approximately SM 21.0. This falls (hereafter referred to as the Trestle Falls) drops vertically about 7 feet.

Habitat below Orofino Falls is used by summer steelhead but apparently unused by spring chinook salmon (Varley and Diggs 1983). Fish passage would have to be provided at the three falls if upper areas of the Orofino Creek drainage were to support self-sustaining runs of either species.

Five additional potential barriers to upstream adult steelhead passage in the upper drainage basin tributaries were also identified during the Phase I study. They were as follows:

Stream	Stream Mile	Barrier Description
Orofino Creek	36	Log Jam
Quartz Creek	2.9	A Potlatch Forest Industries instream mill dam
Rhodes Creek	1.1	Culvert for road crossing
Canal Gulch	0.8	Water supply dam
Trapper Gulch	0.25	Log Jam

TECHNICAL INVESTIGATIONS

Factors Influencing Design Considerations

A. The Clearwater Hvdro Project

On December 16, 1987 the Federal Energy Regulatory Commission issued a license to Clearwater Hydro Limited Partnership (CHLP) to construct, operate and maintain a 2.063 megawatt hydro power generating facility on Orofino Creek. Portions of the license of significance to this project are reproduced below.

1. The proposed project would consist of:
   - A. A 6-foot-high. 65-foot-long concrete dam with negligible impoundment;
   - B. a 6,200-foot-long. 6.5-foot diameter low pressure steel conduit:
   - C. a surge tank:
   - D. a 8OO-foot-long, 65-inch-diameter steel penstock;
   - E. a powerhouse containing generating units with a total rated capacity of 2.063 megawatts (MW);
   - F. a tailrace;
   - G. a 13.2 kV underground transmission line; and
   - H. appurtenant facilities.

2. There are currently no anadromous fish in the area of the proposed project’s diversion structure. Orofino Falls. a 83-foot-high cataract located approximately 800 feet below the project diversion but above the project powerhouse, blocks the migration of anadromous fish.

3. The National Marine Fisheries Service (NNFS) which, as an agent for the Secretary of Commerce, is provided with the authority to prescribe "fishways" for projects proposed for license pursuant to Section 18 of the FPA, 16 U.S.C. § 811. seeks to ensure that, should anadromous fish gain access to Orofino Creek above the Falls, the project would not interfere with the upstream passage of fish past the diversion and their safe return. However, since it is not clear whether bypassing Orofino Falls is feasible, or what form such bypass will take, it is not possible to precisely prescribe the appropriate fishways for the project at this time. NMFS therefore seeks to reserve the authority granted to it by Section 18 to prescribe fishways if and when needed. Specifically, NMFS seeks to reserve the right to prescribe:

A. Modifications to the project's flow regime;

B. Attraction flows and fish guidance structures at or adjacent to the powerhouse;

C. Studies to determine the presence of anadromous fish in the vicinity of the project; and

D. If the studies show it necessary, modifications of the screen design at the project intake in order to protect juvenile salmon and steelhead trout. NMFS would also reserve to itself the authority to approve in writing the project's final functional design drawings and the right to amend or modify any of its Section 18 prescriptions.

4. WMFS recommended that the following continuous minimum flows, or inflow, whichever is less, be released from the project diversion dam for the protection of anadcomous habitat: 50 cubic feet per second (cfs) from March 1 through June 30, and 40 cfs from July 1 through the end of February. The EA for the project includes a discussion of these minimum flows, which were previously recommended by the IDF&G and the U.S. Fish and Wildlife Service. Since these recommended flows would adequately protect the fishery resources of the area, Article 403 of the license requires CHLP to release such flows.

Should the Clearwater Hydro power project be constructed it may provide an opportunity to construct a trap and haul facility at that location. This option was not analyzed. It would be less costly than the trap and haul option analyzed at the power plant site if the power plant were not constructed.

B. Stream Hydraulics

High water flow in Orofino Creek occurs during the months of February, March, April, and May. Spring chinook generally enter the smaller Clearwater tributaries in June and early July. after peak runoff is passed (See Figures 2 and 3). The Phase I report by Clearwater BioStudies, Inc. concluded that a spring chinook run could not be sustained in Orofino Creek without continual outplanting. Steelhead hold in the fall in the Clearwater and migrate into Orofino Creek during the months of February through Way and spawn at any time flow and water temperature seems suitable to them. Stream flow in Orofino Creek during this time is erratic and for each month may vary between 300 cfs to over 2,000 CfS.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
LONG-TERM AVERAGE FLOW	48	71	143	95	547	500	619	475	261	92	41	38
CRITICAL LOW FLOW	40	56	104	61	322	358	560	369	122	52	30	28

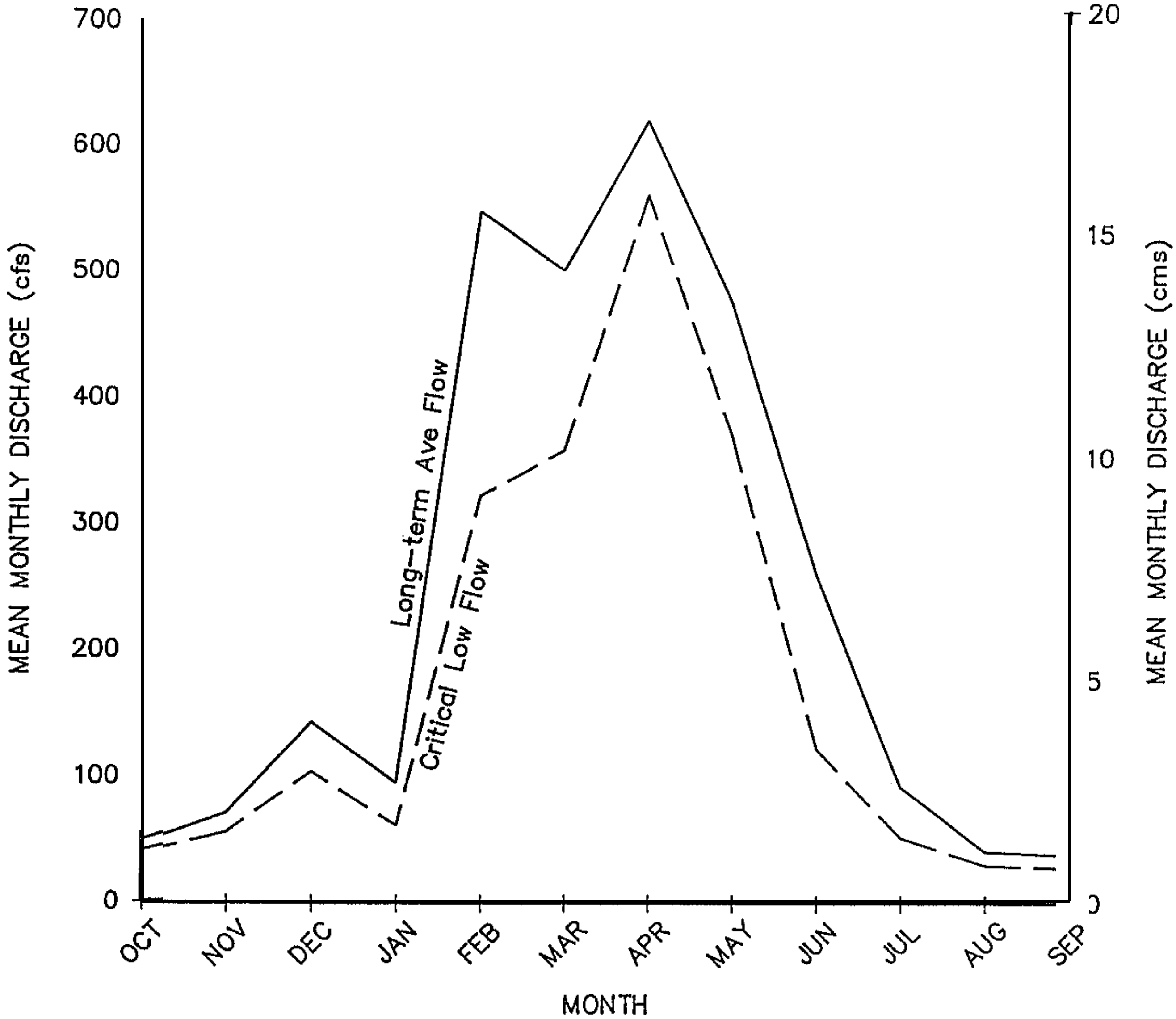

Figure 2. Estimated mean monthly discharges for long-term average, and for critcal low flow conditions at Orofino Falls (source: Warnick, 1984).

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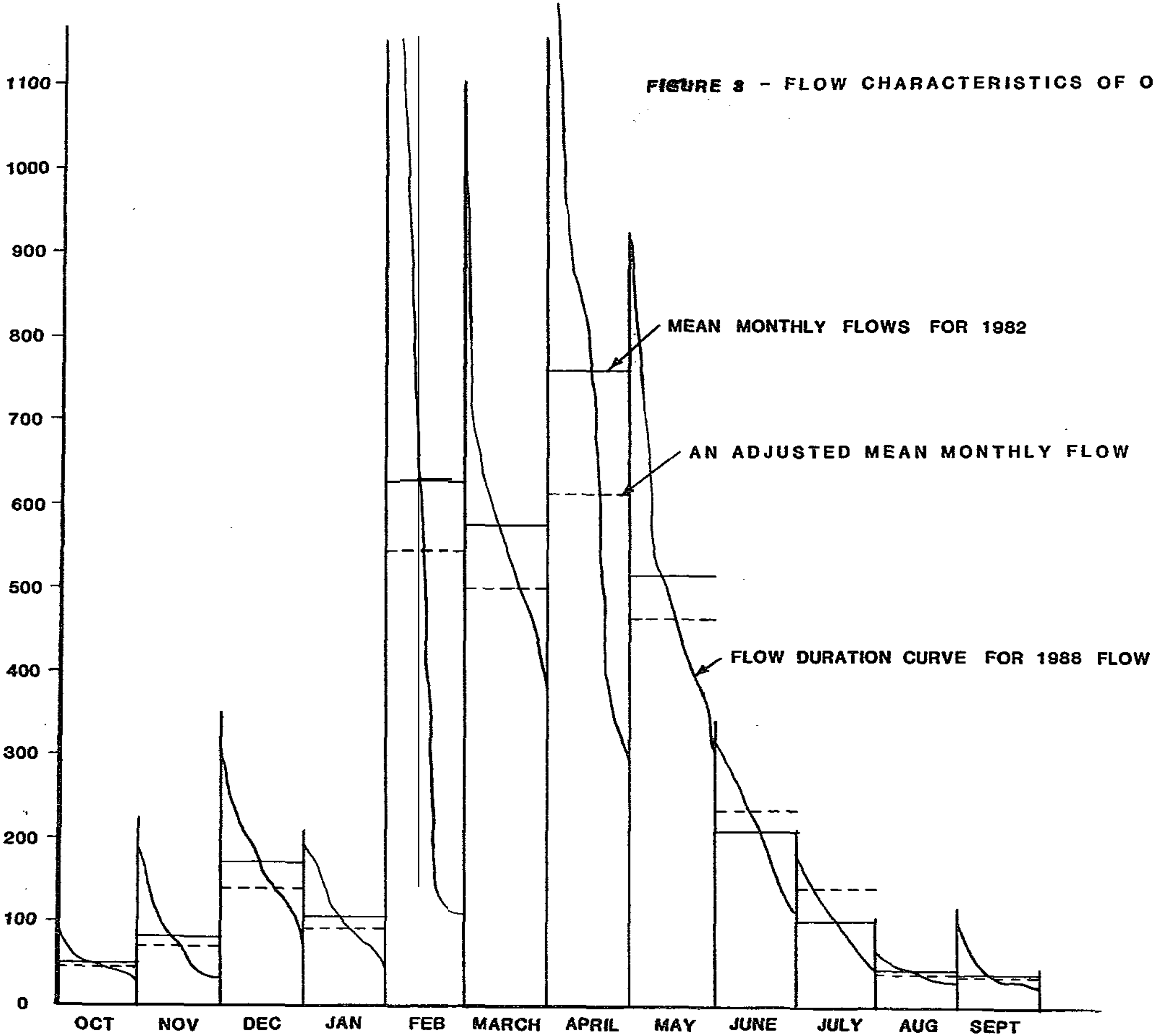


FIGURE 3 - FLOW CHARACTERISTICS OF OROFINO CREEK

CONCEPTUAL DESIGNS

Desians Considered

Based on the above information, this feasibility report will analyze the following options for the enhancement steelhead production:

1. Fish passage structures Upper Falls and Trestle Falls:

   A. Orofino Falls by instream modifications by blasting and construction of instream concrete barriers and installation of a short upstream steep pass ladder.

   B. Orofino Falls by constructing a full length fish ladder into the cliff along the south bank.

2. A Trap and Haul facility at the Clearwater Hydro site.

3. An outplanting program to annual seed the basin with spring chinook fry and and adult summer steelhead.

Ocofino Falls

The preliminary design evaluation of passage enhancement structures past Orofino Falls considered one for the full flow range and one for less costly facilities effective only between flows of 140 cfs and 800 cfs. Facilities proposed for this project are to pass only steelhead.

Orofino Falls, the 530 foot long 83 foot drop cascade in Orofino Creek, is filled with large boulders. Streamflow through the boulders results in a series of pools and falls. The total approximate elevation drop of 83 feet is distributed among 8 to 10 falls. The height of the falls varies between 4 and 12 feet.

Boulders in the cascade are primarily in the 6 to 10 foot size range. The boulders are basalt and many contain joint patterns similar to those observed in the vertical basalt face of the south canyon wall.

The canyon section containing the cascade has a vertical south wall, and sloping north wall. The vertical south wall reaches approximate heights of 30 to 60 feet above the creek. Above the vertical face, the south canyon wall continues to rise on approximately a one to one slope.

The vertical face of the south wall is jointed basalt. Vertical and horizontal joint patterns form hexagonal shaped columns that vary in height from 4 to 8 feet. The joint pattern, typical of basalts, controls the rock fall failure mode of the vertical face, and the size and shape of rock blocks that fall from the face. Joints were observed in many cases to be tightly closed. However, other cases of open joints with separations up to 1 inch were noted. Basalt columns were observed "hanging" on the canyon wall where lower sections of the column fell to the creek bottom. Other local sections of rock on the face are bounded by open joints and appear to have leaned away from the face. One such example is approximately 10 to 15 feet wide, and 15 feet high. located at the approximate midpoint of the cascade.

Boulders on the creek bottom reflect the joint patterns observed in the face of the south canyon wall. Since rock masses bounded by open joints were observed on the south canyon wall, it is concluded that the boulder accumulation in the creek results from rock falls from the vertical face over the past several thousand years.

The sloped north wall of the canyon reflects the presence of soil material that apparently overlays basalt bedrock. The soil mantle is relatively thick since bedrock outcrops were observed only on the south wall, the creek bottom, and at points on north wall near the upper and lower limits of the cascade. The thickness of the soil mantle could reach 20 feet or greater.

Soils on the north side consist primarily of clayey sands, with angular gravel and cobbles. Large boulders also outcrop in the soil mantle. Localized slumping was noted in a small, dry, drainage swale area near the lower limit of the cascade.

Soil conditions for the site were further identified by verbal communication with local Soil Conservation Service (SCS) staff, and review of reports prepared for the hydropower project proposed for the site. SCS information indicates that the soils at the site can contain more than 40 percent by weight clay. and 40 to 50 percent by weight rock (gravel and cobbles). This information is generally consistent with field observations of clayey to gravelly clayey sands.

SCS information indicates that soils on the site are susceptible to slumping. However. the slumps are primarily superficial (shallow), and occur most often in the draws and side drainages that feed the creek. Though these drainages are not live streams, they are prone to moisture accumulation and associated soil saturation. These conditions promote a higher slumping probability for drainage and draw areas.

The SCS staff cited two mass slope failures that have occurred on the railroad upstream at the site. Slope debris had to be removed from the railroad tracks.

Review of the Environmental Impact Statement (EIS) prepared for the hydropower project indicated basalt is the prevailing bedrock type, Lake deposits, clay and ash interbeds were reported to also comprise the bedrock geology. soils are described as silt and gravelly loam derived from loess. and weathering of basalt. Erosion potential is described as moderate to severe depending on slope and soil texture.

The Burlington-Northern railroad tracks are immediately above the Falls on the north side. Previous side hill slope slides have brought the top of the side slope to within ten to fifteen feed of the roadbed. The Geological conditions that indicate the north slope to be unstable and subject to slides. The fact that previous slides have come close to damaging the road bed leads to recommending against construction of a fish passage facility on the north side of Orofino Falls.

Alternatives remaining for passage at Orofino Falls include in channel modifications, a formal ladder on the south side, a combination of both options, or a capture facility with an overhead tram way for transportation to above the falls. After preliminary investigations, the following two plans were developed.

1. Instream modifications with a short section of a prefabricated fish ladder at the upper end.

2. A formal fish ladder for the entire channel length.

During an early May 1988 visit at riverflows of about 230 cfs a steelhead was observed in a pool about 200 feet up from the downstream end of the falls. On this trip, through a combination of pictures, notes, and general observations a plan was developed to add small instream concrete structures to form a series of pools such that steelhead could move upstream to a short steep pass ladder covering the upper 30% of the falls. This option, shown as Option A on the large drawing in Appendix B, and in the series of Figures 4 through 9, will allow fish to pass through the falls area by using some existing natural pools and other pools enhanced by streambed modifications.

It has, however, two disadvantages. Minimum streamflow at which fish can easily pass is estimated at about 140 cfs. This will require control of the withdrawal rate for Clearwater Hydro, should it proceed, to be limited to flows above 140 cfs between January and May of each year. Steelhead may not be able to pass through the modified falls at flows exceeding 600 CfS. These passage restrictions because of flow may limit their passage time to less than 15 days during each passage month. This should not have a major impact as summer steelhead have a longer spawning period and can wait in quiet pools for acceptable passage conditions.

Option B (see the large drawing in Appendix B) proposes a prefabricated metal fish ladder installed in a pathway blasted out of the south bank. The proposed prefabricated ladder is designed to pass only steelhead and would be too small for chinook. Water from upstream would be passed in a pipeline beside or under the ladder to reduce flow in the ladder and increase the volume of attraction water exiting the lower end, as shown in Figures 10 6 11.

Upper Falls

The upper falls is formed by a basalt ledge with approximately 20 feet of vertical drop over a horizontal distance of 140 feet. It is divided into 3 falls by two benches at each end. The first and third drops of about two feet are passable while the center area drops about 12 feet in 40 feet.

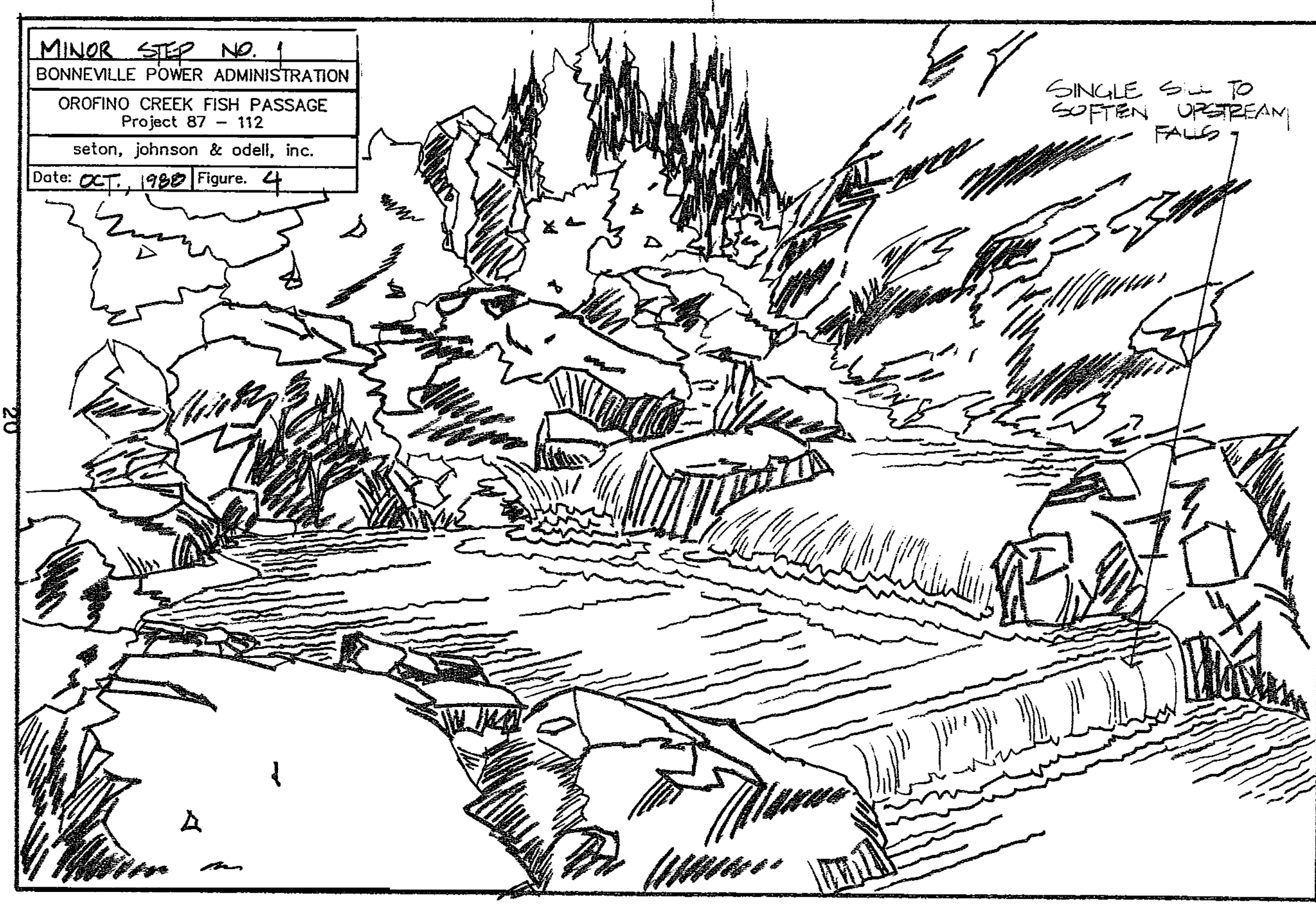
MINOR STEP NO. 1

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

seton, johnson & odell, inc.

Date: OCT., 1988 Figure. 4



MINOR STEP NO. 2

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

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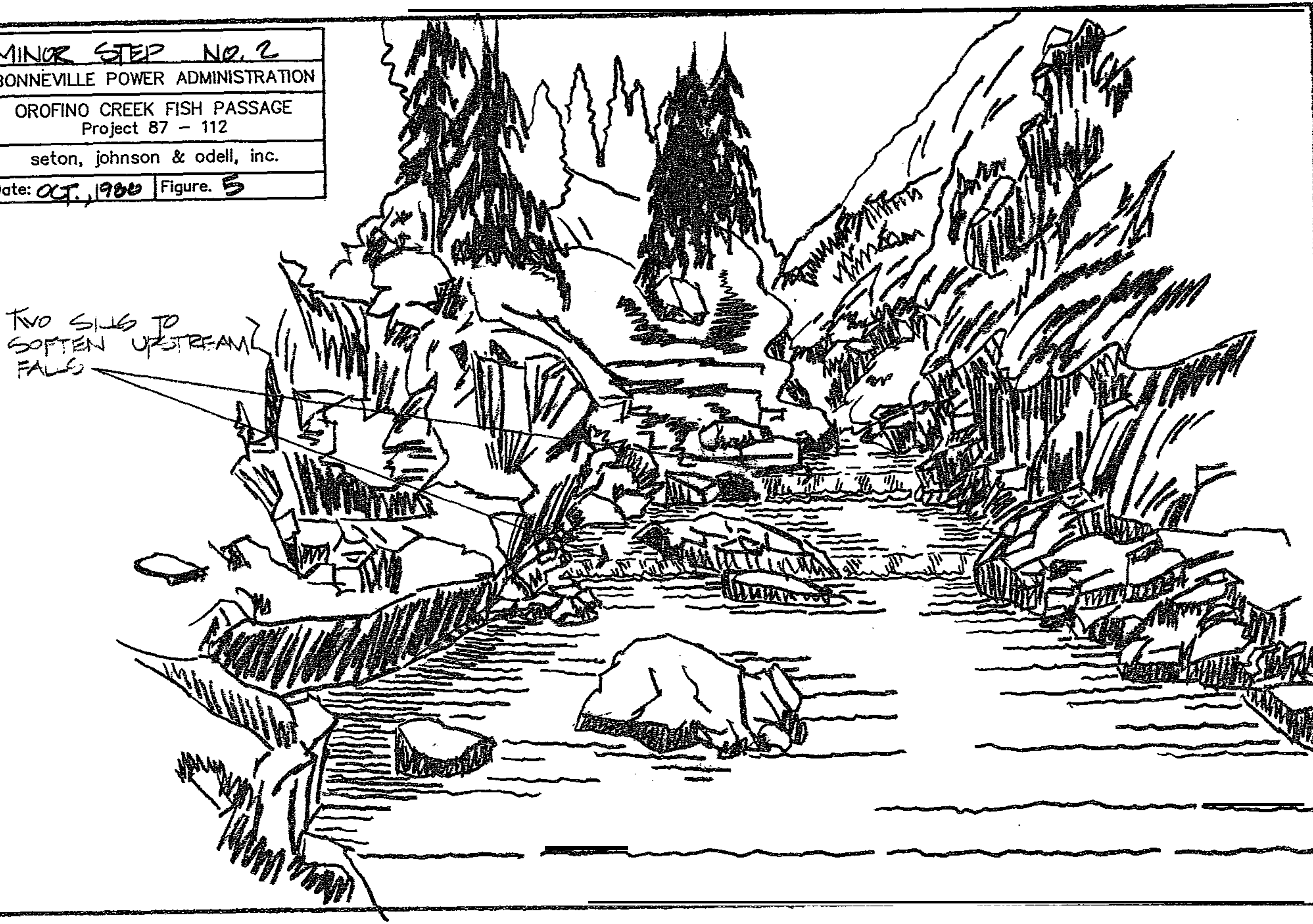
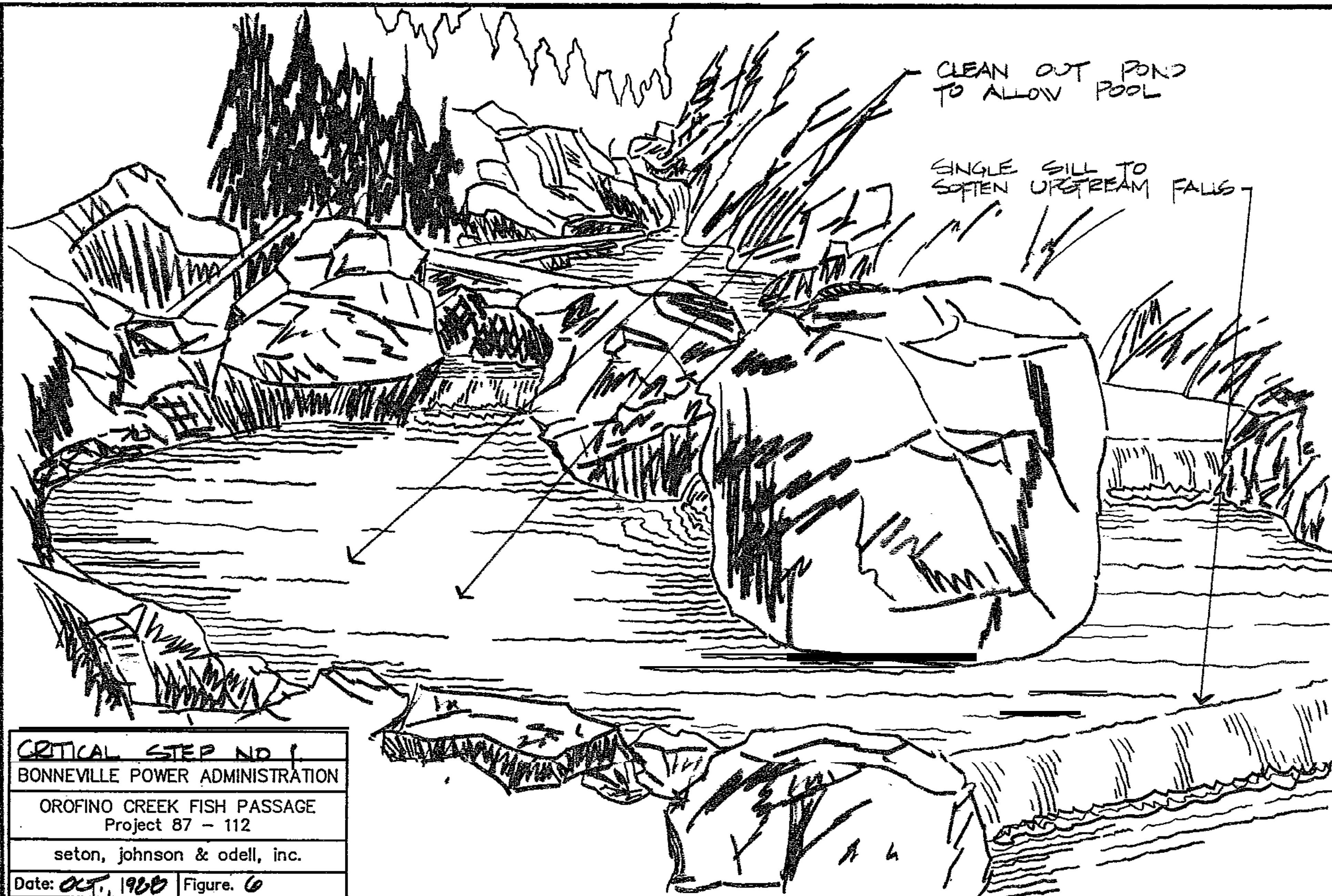
Date: OCT., 1988 | Figure. 5





CRITICAL STEP NO 1

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

seton, johnson & odell, inc.

Date: OCT, 1988 | Figure. 6

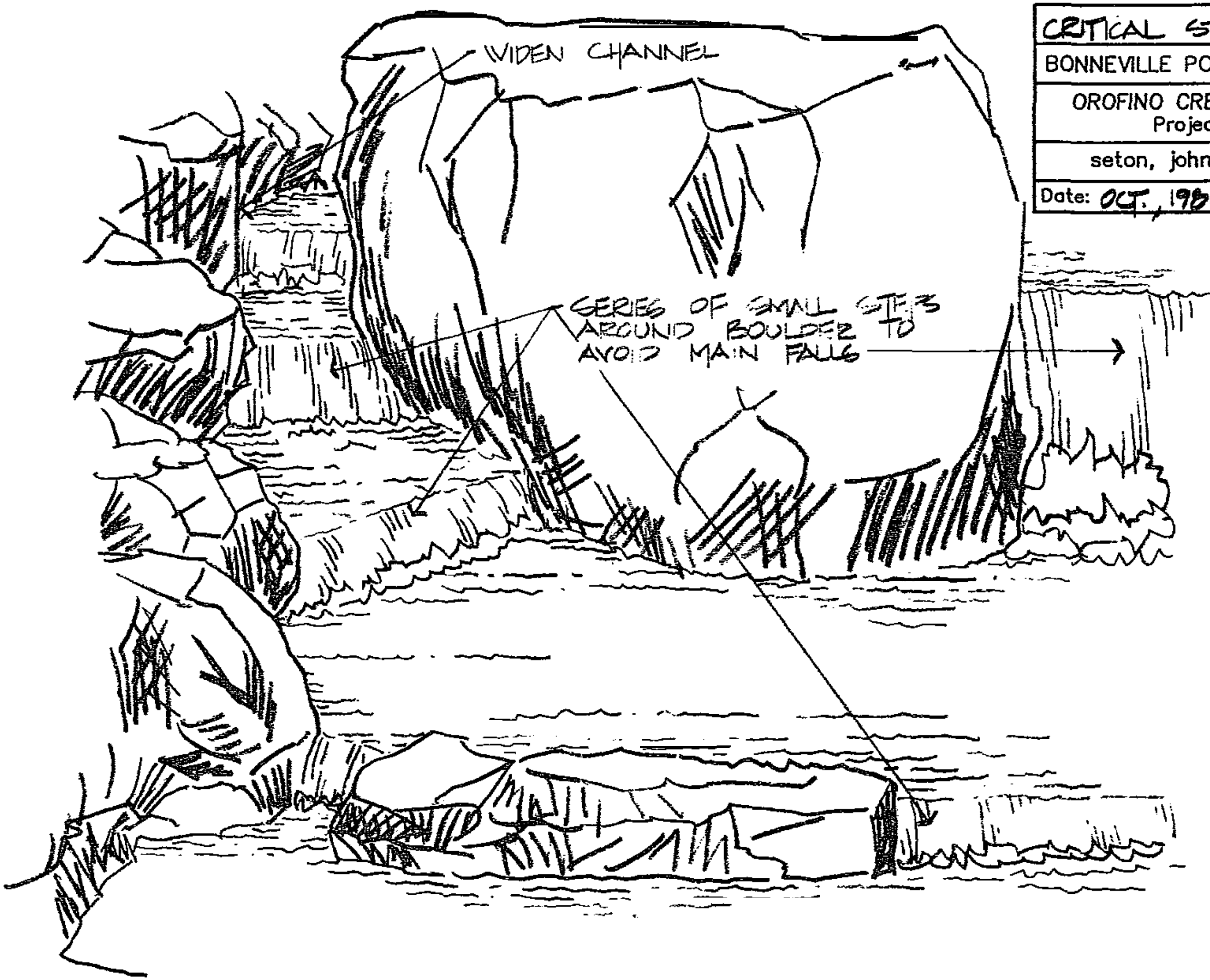
CRITICAL STEP NO. 2

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

seton, johnson & odell, inc.

Date: OCT., 1988 | Figure. 7



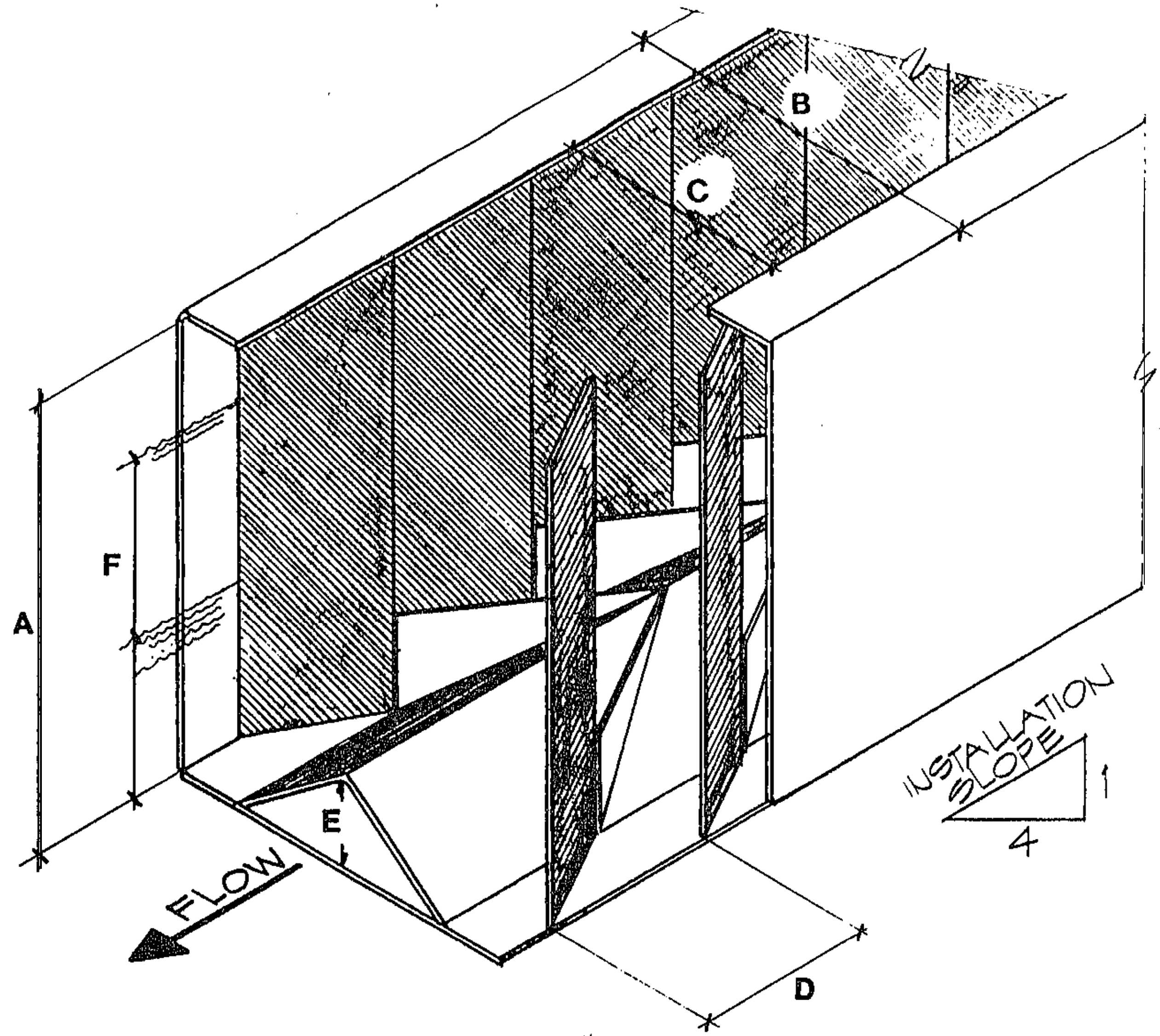
CRITICAL STEP NO. 3

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 - 112

seton, johnson & odell, inc.

Date: OCT., 1988 | Figure. 8

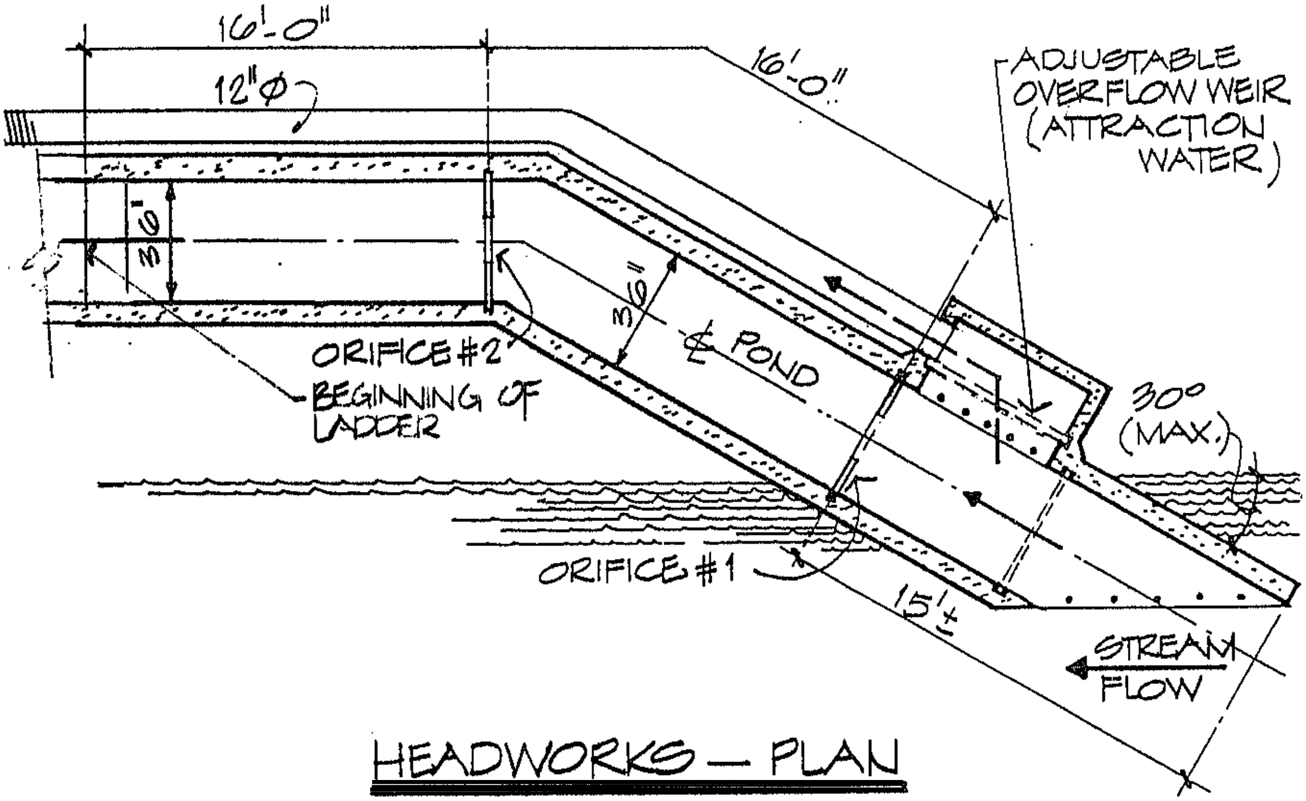


"STEEP PASS" SECTION

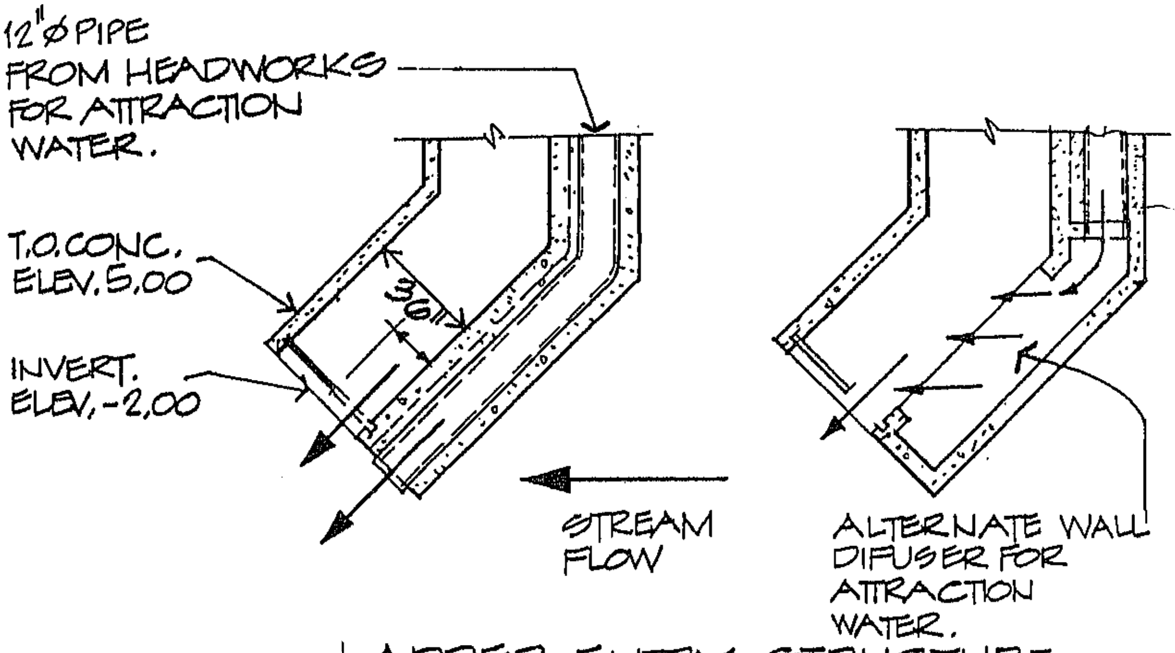
(TYPICAL DIMENSION)

A. WALL HEIGHT ——— 3.0 ft
B. WIDTH ——— 20 INCHES
C. SLOT WIDTH ——— 13.5 INCHES
D. SIDE PANEL SPACING ——— 9.6 INCHES
E. BOTTOM PANEL ——— 5 INCHES
F. WATER DEPTH ——— 18-30 INCHES
DISCHARGE 5-9 CFS
VELOCITY 3-3.2 ft/s

STEEP PASS	
BONNEVILLE POWER ADMINISTRATION	
OROFINO CREEK FISH PASSAGE Project 87 - 112	
seton, johnson & odell, inc.	
Date: OCT., 1988	Figure. 9



HEADWORKS — PLAN

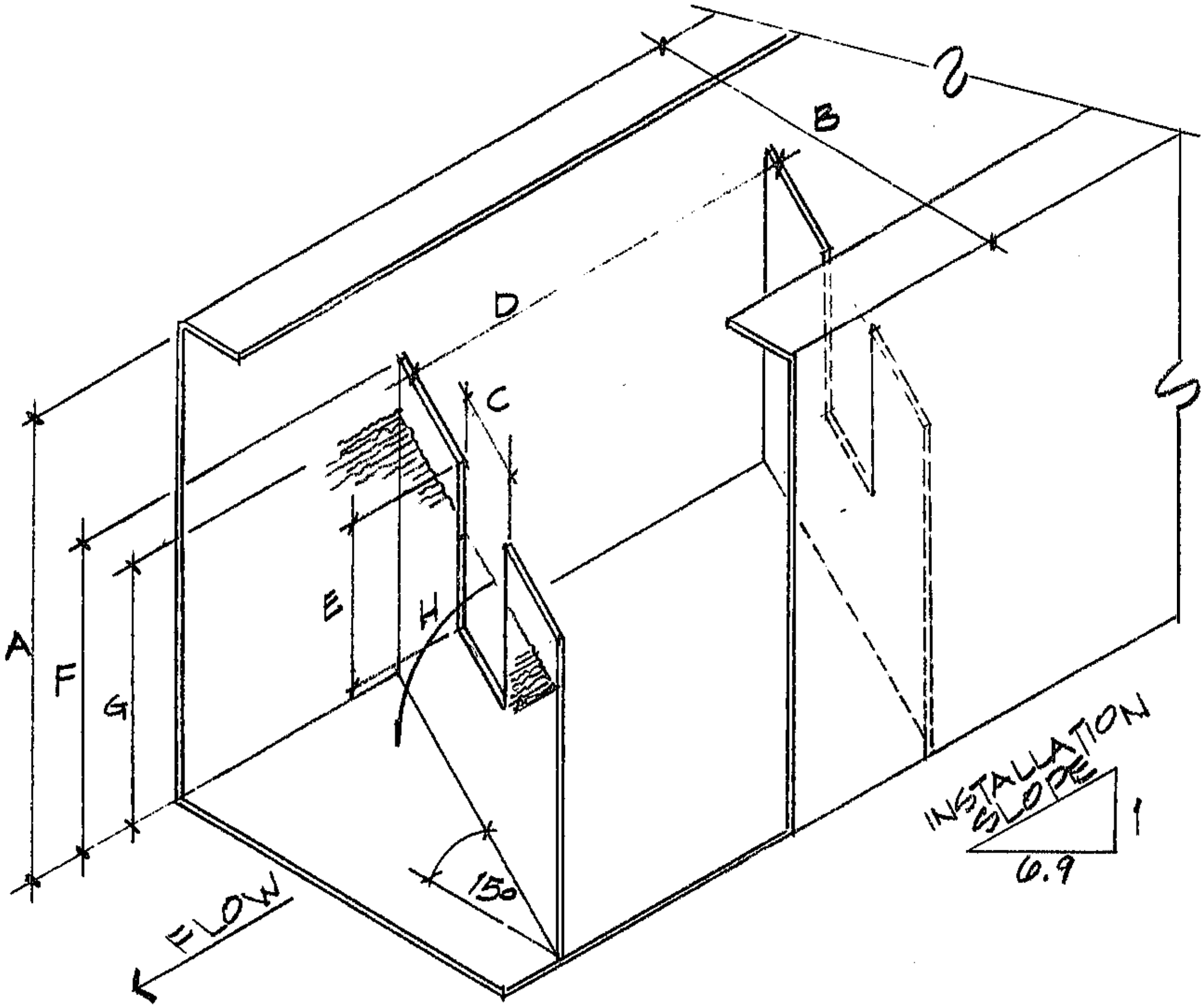


LADDER ENTRY STRUCTURE

NOTE: DIMENSIONS SHOWN ARE APPROXIMATE

seton, johnson & odell inc. consulting engineers portland, oregon seattle, washington	project BONNEVILLE POWER ADM. OROFINO CREEK FISH PASSAGE			
	dwg. title HEADWORKS & ENTRY STRUCTURE			
	designed CH / BMJ	drawn MBW	approved BMJ	date OCT, 1983	dwg. no. 10

PORTLAND PRECISION INSTRUMENT



FISH PASSAGE SECTION

(TYPICAL DIMENSION)

A.	WALL HEIGHT	4.0 FT.
B.	WIDTH	3.0 FT.
C.	SLOT WIDTH	12 IN.
D.	BAFFLE SPACING	6.0 FT.
E.	SLOT DEPTH	18 IN.
F.	BAFFLE DEPTH	3.0 FT
G.	WATER DEPTH	2.5 FT.
H.	VELOCITY	2.5-3.0 FT/SEC.

FISH PASSAGE	
BONNEVILLE POWER ADMINISTRATION	
OROFINO CREEK FISH PASSAGE Project 87 – 112	
seton, johnson & odell, inc.	
Date: OCT., 1988	Figure. 11

Examination of the basalt surface in the channel indicates that the rock is fresh, very hard, and durable. Fracture patterns dissect the rock surface into cubic to hexagonal blocks generally from 2 inches to 2 feet in width. The fractures are tight and effectively interlock the basalt blocks to form a surface with very high resistance to erosion.

Alternatives to improve fish passage include construction of a passage structure on either side of the falls, or modification of a portion of the falls.

The basalt will provide an excellent foundation and anchor material for a fabricated fish passage structure. The north streambank is a sloping basalt outcrop and is free of brush in contrast to the south bank.

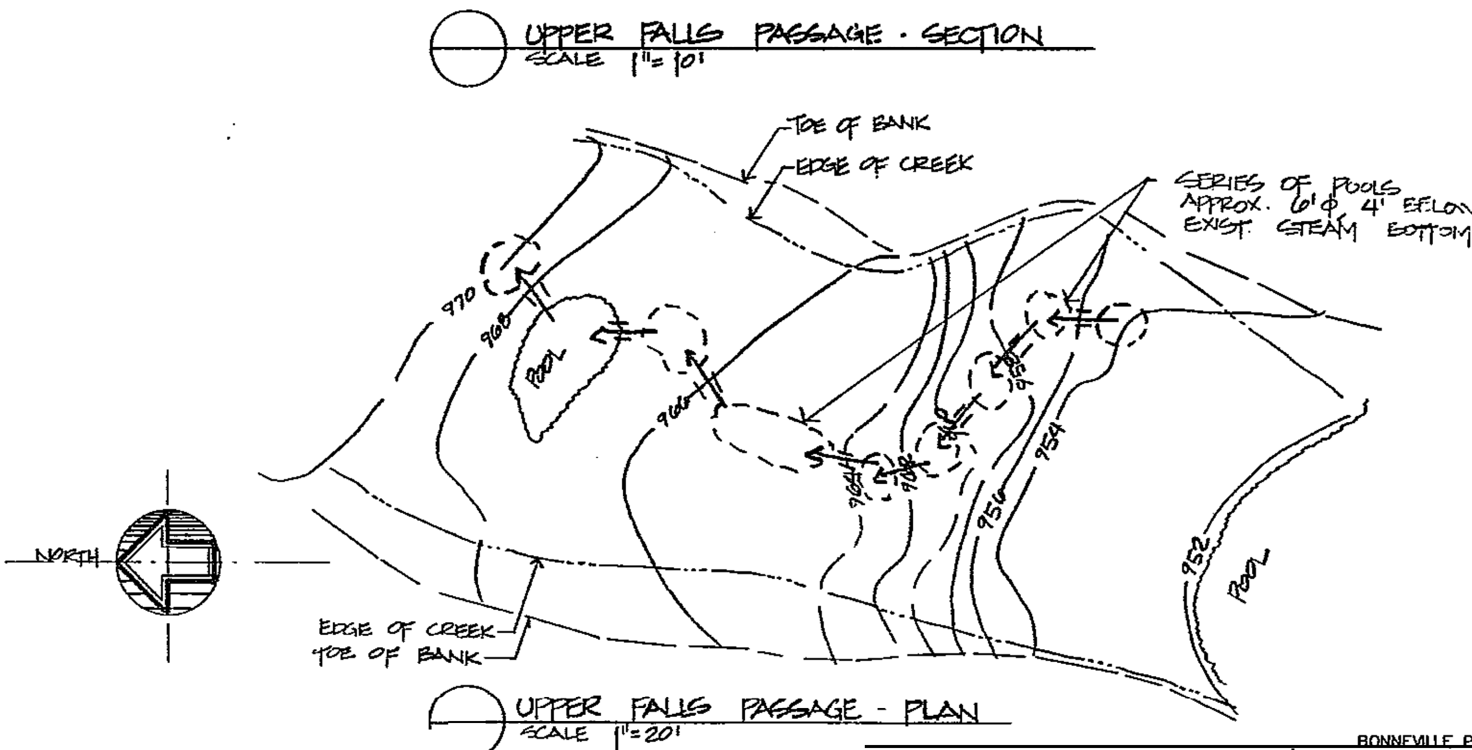
Modification of the falls to provide a passable configuration could be done by blasting that takes advantage of the joint patterns in the basalt ledge. The midpoint bench, and perhaps the falls, is controlled by primary joints that cross the stream at approximately 90 degrees to the flow direction. These joints are spaced at approximate 10 to 15 foot intervals and are open rather wide in contrast to the cubic and hexagonal block patterns that prevail on the rock surface.

Hydraulic forces have removed basalt fragments from the trace of the primary fracture on the midpoint bench. This has opened the fracture to a channel approximately 1 foot wide that directs a component of streamflow laterally toward the south bank over an approximate 4 to 1 (25%) grade. The channelized flow empties into a pool adjacent to the south bank. A shallow pool is located at the head of the channel on the bench between the two major falls.

Blasting of pools along the fracture could be done to provide resting pools and additional flow between the bottom pool and the bench pool. Light blasting at the bench pool site could also be done to increase the size and depth of the pool to accommodate the needs of fish to reach the top of the falls. By consideration of the fracture patterns in the rock, channel and pool improvements could be accomplished with a portable air hammer, and some blasting at the more resistant points. This option is illustrated in Figure 12.

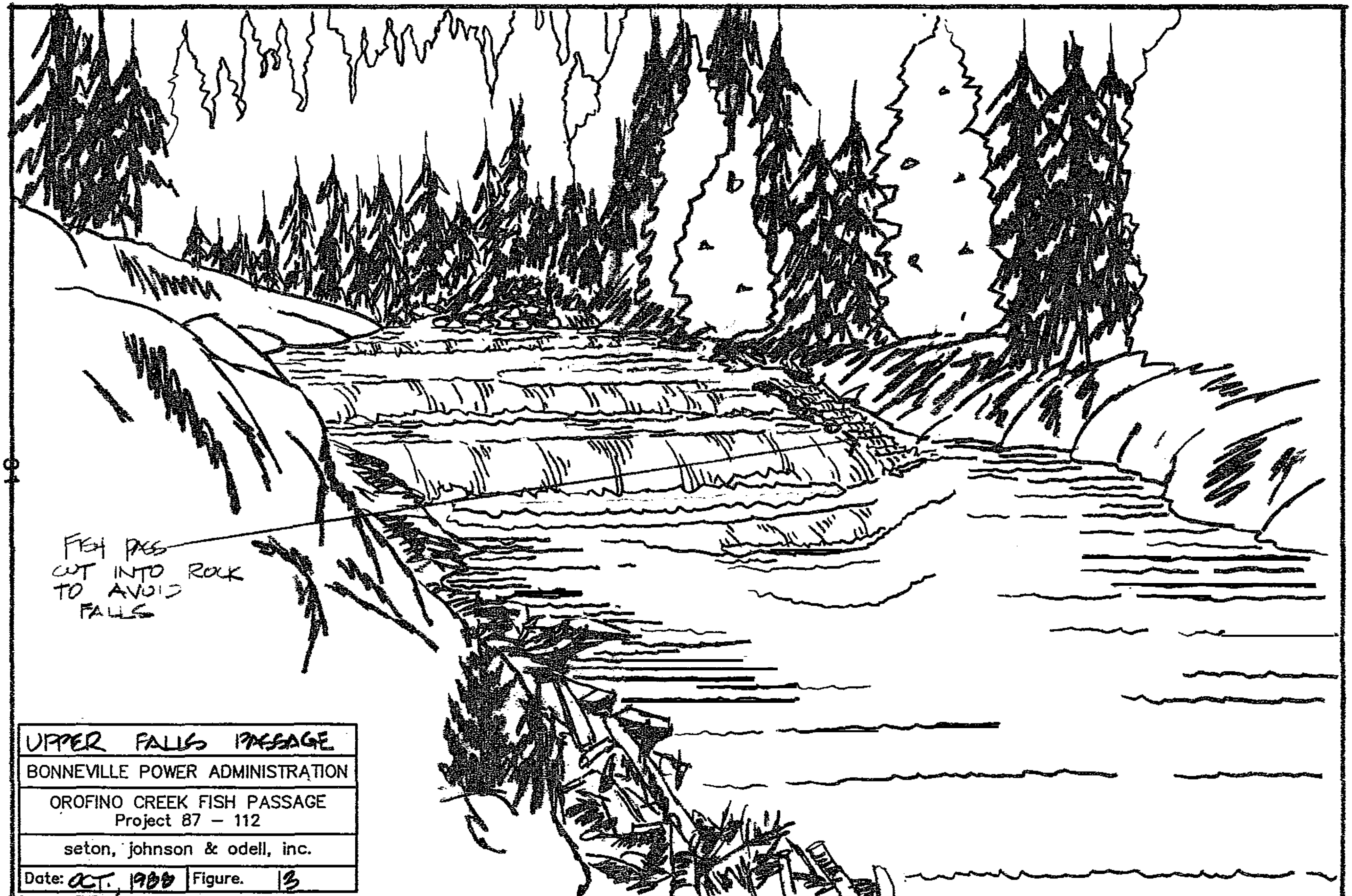
Heavy flows over the falls could overwhelm the lateral flow component in the improved channel and pool system. In fact. the pool at the midpoint bench will not exist beyond a certain higher flow than was observed during the July site visit. For this reason, the option of blasting holes in the slide was rejected.

Placement of a 50 foot long steep pass ladder along the south bank in a channel constructed by blasting offers a second and more reliable passage alternative. This option is shown in Figures 13 and 14.



BONNEVILLE POWER ADMINISTRATION

seton, johnson & odell inc. consulting engineers portland, oregon seattle, washington	project	OROFINO CREEK FISH PASSAGE Project 87 - 112			
	dwg. title	UPPER FALLS PASSAGE - OPTION 2			
	designed BMJ/CH	drawn MEW	approved BMJ	date OCT. 1988	dwg no 12



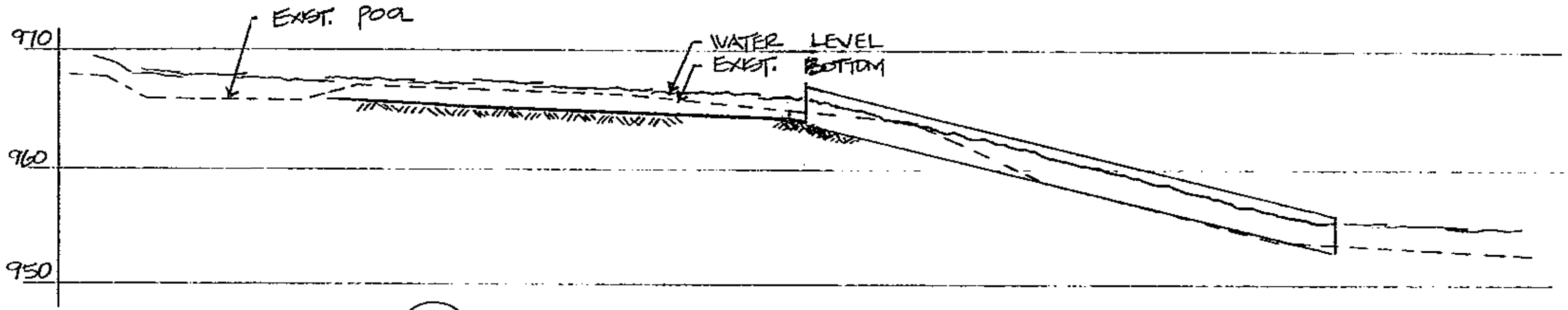
UPPER FALLS PASSAGE

BONNEVILLE POWER ADMINISTRATION

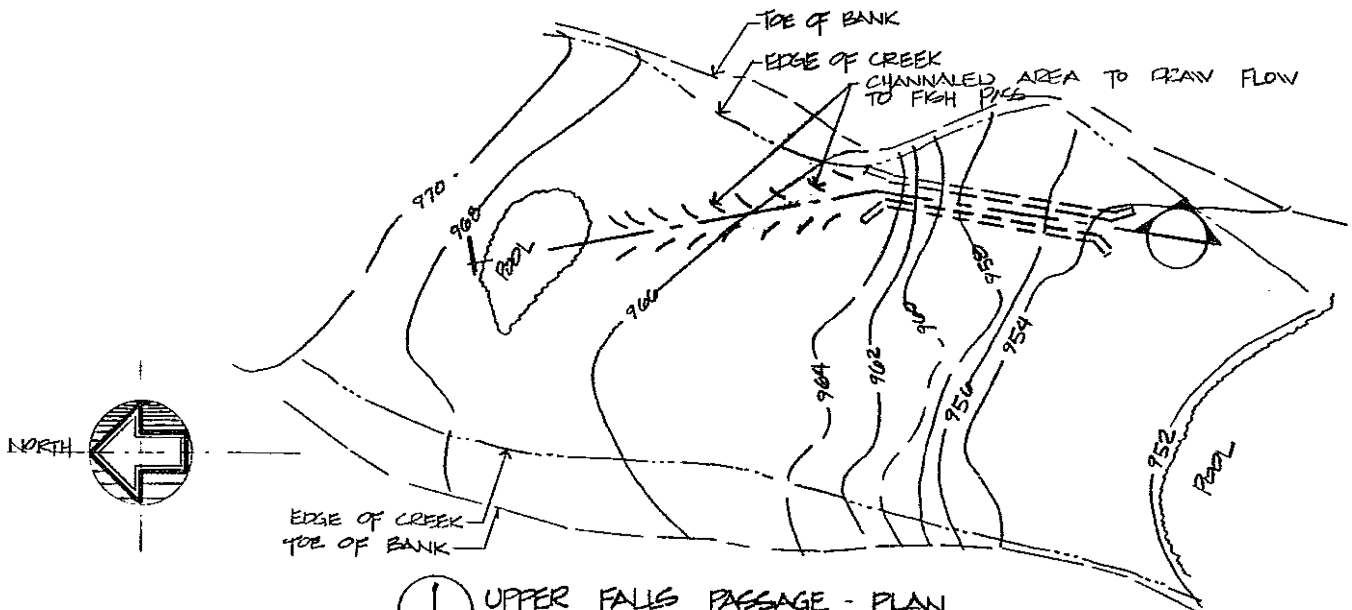
OROFINO CREEK FISH PASSAGE
Project 87 — 112

seton, johnson & odell, inc.

Date: OCT. 1988 | Figure. 3



2 UPPER FALLS PASSAGE - SECTION
SCALE 1"= 10'



1 UPPER FALLS PASSAGE - PLAN
SCALE 1"= 20'

BONNEVILLE POWER ADMINISTRATION

seton, johnson & odell inc. consulting engineers portland, oregon seattle, washington	project	OROFINO CREEK FISH PASSAGE Project 87 - 112			
	dwg. title	UPPER FALLS PASSAGE - OPTION 1			
	designed	drawn	approved	date	dwg. no.

The Trestle Falls

A small falls is located immediately downstream of two concrete footings supporting a railroad trestle. Placement of a short (about 30' long) steep pass ladder through the rock under the Trestle may be the least costly approach to enhancing fish passage. However, blasting the channel may weaken the rock base holding the trestle footings. Construction of two concrete sills in the downstream pool to raise the water level and form two additional pools below the falls will shorten the rise distance to about 2 feet per drop and provide a deep hole below each falls.

Submerged slots should also be installed in the gills to provide underwater passage options. This design option is shown in Figure 15 and 16.

Other Upstream Barriers

During Phase 1 of this contract, five other potential upstream fish barriers were identified. They were:

1. Quartz Creek - An R-foot high dam in the creek used to divert most of the flow into a firewater pond and the log pond.

2. Canal Gulch - An 8 foot high dam used to store water for the downstream community.

3. Rhodes Creek - An unbaffled culvert.

4. Orofino Creek (SM36) log jam (since removed).

5. Trapper Gulch - log jam.

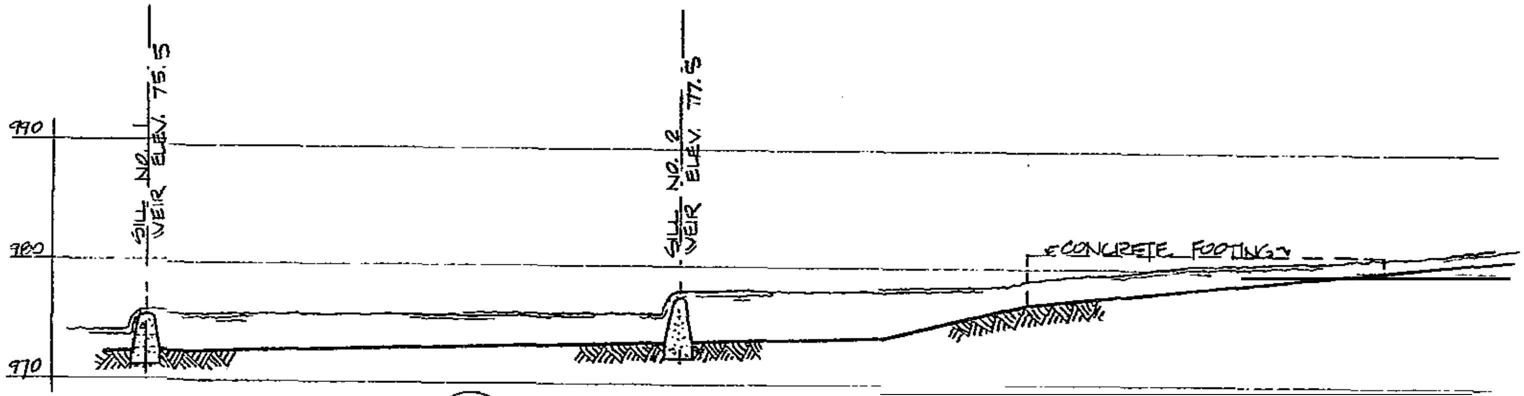
SILLS @ TRESTLE

BONNEVILLE POWER ADMINISTRATION

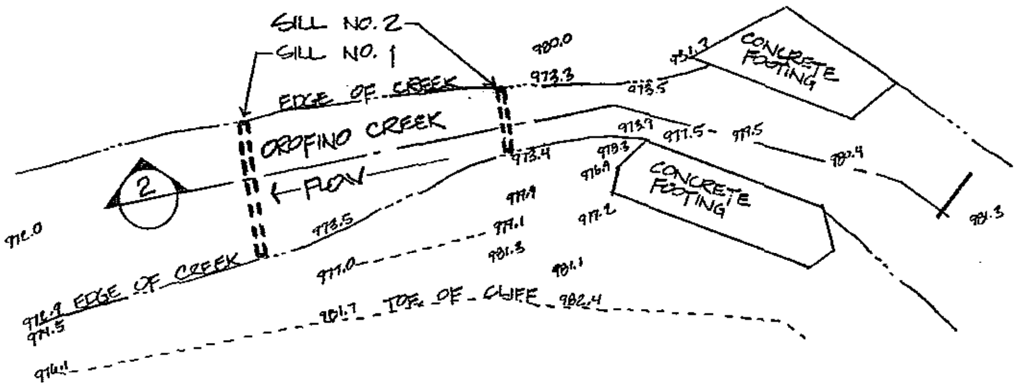
OROFINO CREEK FISH PASSAGE
Project 87 – 112

seton, johnson & odell, inc.

Date: OCT., 1988 | Figure. 5



2 SILLS AT TRESTE · SECTION
SCALE 1"=10'



1 SILLS AT TRESTLE - PLAN
SCALE 1"=20'

BONNEVILLE POWER ADMINISTRATION

seton, johnson & odell inc. consulting engineers portland, oregon seattle, washington	project	OROFINO CREEK FISH PASSAGE Project 87 – 112			
	dwg. title	SILLS AT TRESTLE			
	designed BMJ/CH	drawn MBW	approved BMJ	date OCT, 1988	dwg. no. 16

The Mill Dam on Quartz Creek has an adequate fish ladder but needs operating attention to control the percentage of flow passed through the fish ladder. A rack type barrier dam should be constructed on the bypass channel to direct fish into the existing ladder.

The Canal Gulch water supply dam has an existing discharge channel in which removable low cost sills could be constructed to pass fish. These are shown in Figures 17 and 18. Production above this point will be minimal and modifications to enhance passage are not recommended.

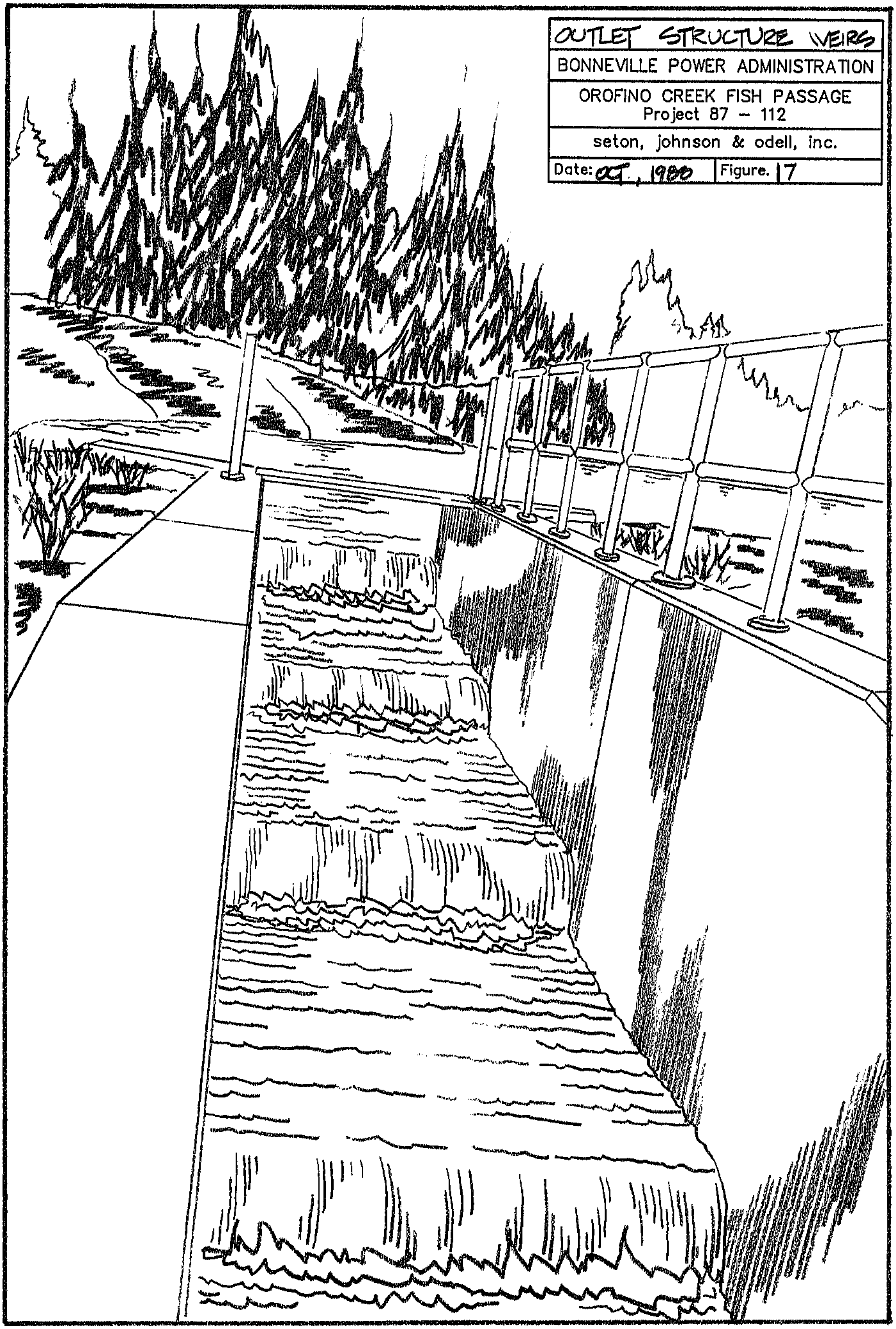
The culvert in Rhodes Creek was inspected at high flow and was found to be passable.

The log jam in Orofino Creek has been removed by an unknown party and is no longer a barrier.

The only other remaining barrier needing attention is the log jam in Trapper Creek. This could be removed at low cost.

Trap and Haul

The trap and haul option requires cooperation from Clearwater Hydro Power. The trap and collection facilities will be at their generation site as it is the only accessible site. Their tailrace can supply the attraction water, and their access road could be used. If Clearwater Hydro Power does not construct their project, the trap and haul project would be built on the same site but would require an access road through private property. Figure 19 shows the basic trap and haul structure used for the estimate. The cost estimate in this report was based upon no hydro project and hauling trapped fish around all barriers.



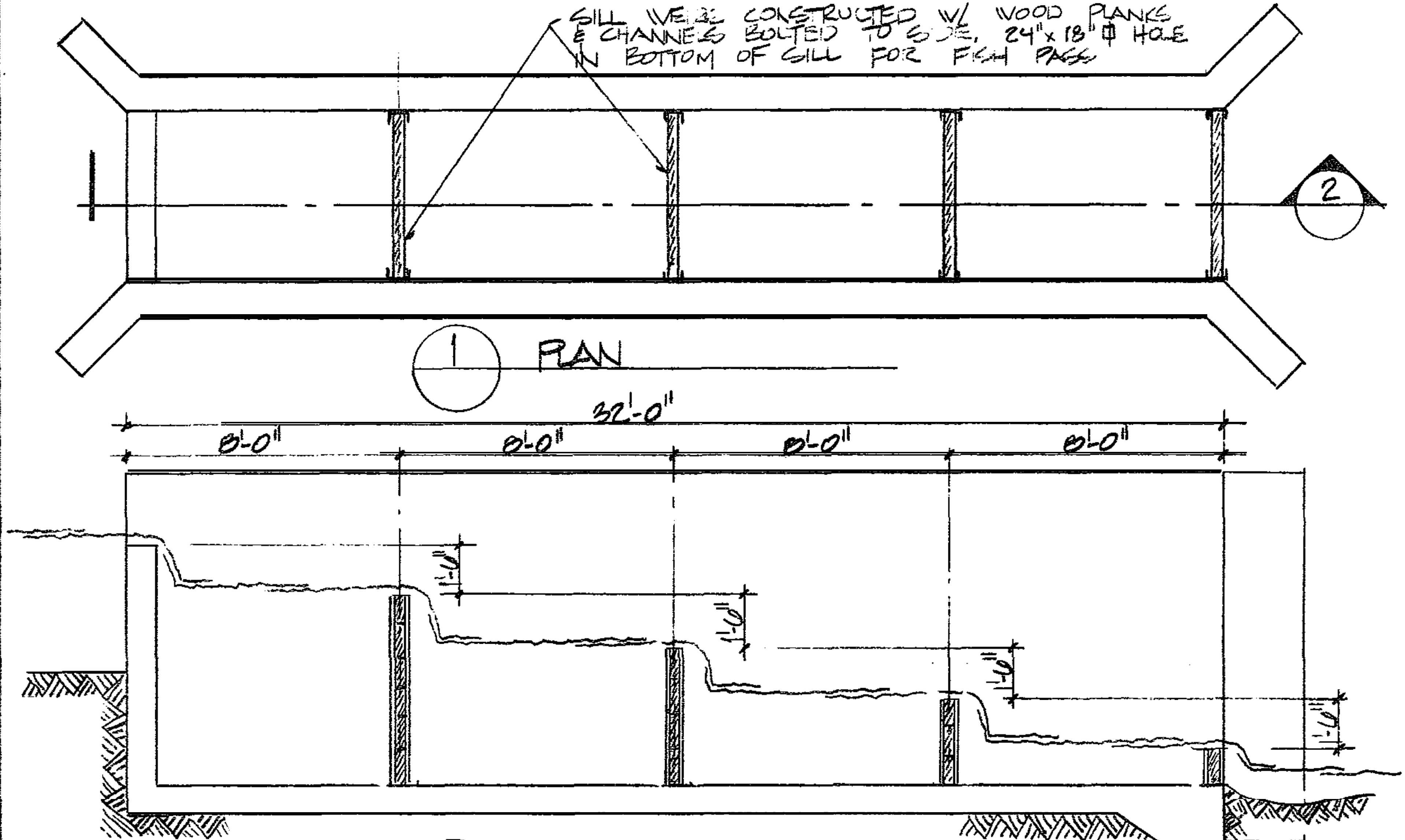
OUTLET STRUCTURE WEIRS

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

seton, johnson & odell, inc.

Date: OCT., 1988 | Figure. 17



OUTLET STRUCTURE

BONNEVILLE POWER ADMINISTRATION

OROFINO CREEK FISH PASSAGE
Project 87 – 112

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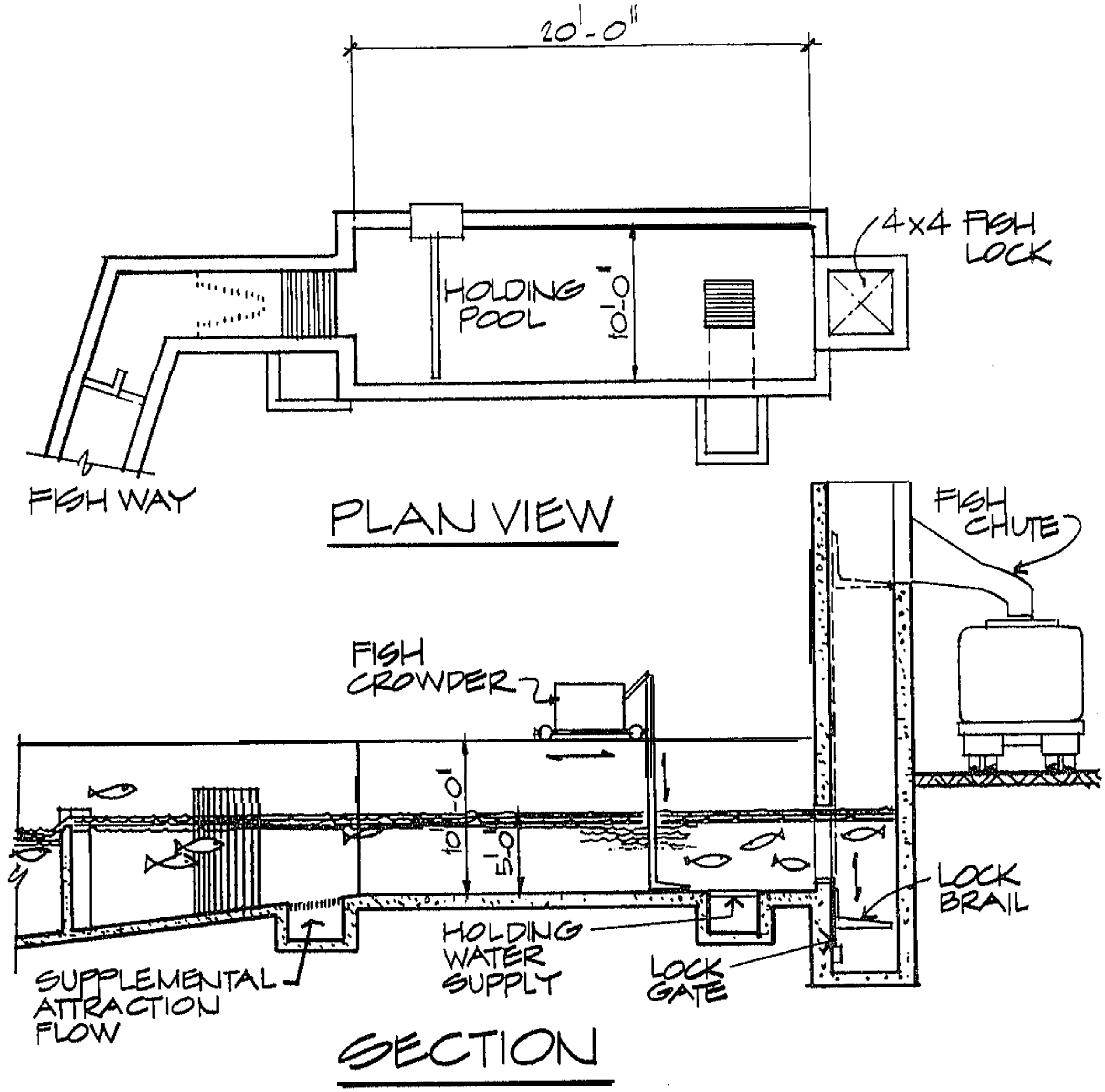
Date: OCT, 1988 | Figure. 10



FISH TRAP/HOLDING - LOADING FACILITIES

TRAP & HAUL SYSTEM
BONNEVILLE POWER ADMINISTRATION
OROFINO CREEK FISH PASSAGE Project 87 – 112
seton, johnson & odell, inc.
Date: OCT. 1988 | Figure. 19

HATCHERY OUTPLANTING

High costs of providing adult fish passage at Orofino Falls and the expectation that adult spring chinook would fare poorly in Orofino Creek during summer led to consideration of hatchery outplanting as an alternative approach to producing anadromous salmonids above the falls. Surplus adult steelhead and spring chinook fry from a nearby hatchery would be released into habitat upstream of Orofino Falls to allow natural production of smolts. Subsequent returns of adult summer steelhead and spring chinook would be available for harvest at numerous downstream locations. A high-intensity terminal fishery could be developed at the base of Orofino Falls.

Summer Steelhead

Adult B-run steelhead from Dworshak National Fish Hatchery (DNFH) would be released at several locations within the drainage above Orofino Falls (Table A-l) to ensure full seeding of habitat that could have been made accessible to steelhead through passage enhancement. I estimate that a total of 513 adult DNFH steelhead will have to be released at these locations each spring to obtain maximum steelhead smolt production. This estimate is based on the following assumptions:

0 Potentially accessible habitat in the drainage above Orofino Falls is capable of producing 13.846 steelhead smolts (Huntington 1988)

0 6,000 eggs/mature female DNFH steelhead (Howell et al. 19851

0 a set ratio of 3 females/Z males for DNFH steelhead (Howell & al. 1985)

0 a 1.5% egg-to-smolt survival rate (Bjornn 1978) for wild Idaho steelhead

- egg-to-smolt survival for outplanted DNFH steelhead will be half that of wild Idaho steelhead.

Spring Chinook

Approximately 500,000 hatchery spring chinook fry (300/lb; about 2" long) would be outplanted above Orofino Falls each spring to fully seed suitable rearing habitat with juveniles. Potential fry liberation sites are listed in Table A-2. Assuming a reasonable fry-to-smolt survival rate of about 7.5% (C. Petrosky. IDFG. pers comm.), it is anticipated that the proposed program would ensure maximum production of spring chinook smolts in the Orofino Creek drainage.

Table A-l. Potential liberation sites for adult steelhead to be released into the Orofino Creek drainage under Alternative 4.

- Orofino Cr. above Orofino Falls (SK 10)
- Orofino Cr. at Cow Cr. Bridge (SK 32)
- Orofino Cr. at Poorman Bridge (SK 37)
- Orofino Cr. at Quartz Cr. Bridge (SK 45)
- Orofino Cr. near Cardiff (SK 50)
- Rhodes Cr. at Clearwater Gulch (SK 3)
- Quartz Cr. at Trail Cr. (SK 6)
- Canal Gulch above Duffy Dam (SK 2)

Table A-Z. Potential chinook fry liberation sites for Alternative 4.

- Orofino Cr. at Poorman Bridge (SK 37)
- Orofino Cr. at Quartz Cr. Bridge (SK 45)
- Orofino Cr. near Cardiff (SK 50)

- Orofino Cr. near Rosebud Cr. (SK 57)
- Rhodes Cr. at Clearwater Gulch (SK 3)
- Rhodes Cr. below Pierce Cr. (SK 5)
- Rhodes Cr. at PFI Road Crossing (SK 10)
- Shanghai Cr. at Upper PFI Bridge (SK 3)
- Quartz Cr. below Jaype (SK 4)
- Quartz Cr. at Trail Cr. (SK 6)
- Trail Cr. below Little Beaver Cr. (SK 2)
- Little Beaver Cr. (SK 2)
- Canal Gulch above Duffy Dam (SK 2)

CONSTRUCTION SCHEDULE

All construction for this project must be done during low flow months between July and November. August and September have the lowest flow and instream work should be scheduled for that time period.

Following is a proposed schedule for completion of any of the construction options proposed. It is important that scheduling occur as shown in order to take advantage of low stream flows and suitable weather conditions.

1. Final Engineering

   Begin June 1, 1989

   End December 30. 1989

2. Select Contractors - April 1. 1990

3. Construction

   Begin June 1, 1990

   End October 30, 1990

PROJECT COST ESTIMATES

Construction costs estimated for each option reviewed in this report are based on access to each site being provided free of charge, except for actual costs for labor and transportation, by the Burlington Northern railroad and by cooperation from landowners in providing easements and property free of charge. Costs for minor upstream modifications are included as one item in all options except for outplanting and seeding with adult steelhead and chinook fry.

Permits for blasting and instream work are to be provided by EPA.

These estimates are contained in Tables 1 through 4 and are used in the attached cost benefit analysis.

TABLE 1A
Cost Estimate

Passage Orofino Falls
Instream Modification Option

A. Orofino Falls		
Mobilization		$ 20,000
Concrete 100 yd3		100,000
Blasting		20,000
Ladder (counterflow sections) & Flume		40.000
Services		
Surveying	$10,000	
Geotechnical	10,000	
Engineering/Inspection	25,000	45,000
Subtotal		225,000
Contingency (25%)		55,000
CAPITAL COSTS		$280.000
Annual O&M		$ 20,000
Upstream Facilities (Table 3)		
Capital Costs		$160.000
Annual O&M		15,000
Subtotal		$195,000
Total		
Capital Costs		$440.000
Annual O&M		$ 35,000

TABLE 1B
Cost Estimate

Passage at Orofino Falls
Full Ladder Option

A. Orofino Falls

Mobilization		$ 20,000
Concrete 100 yd3		100,000
Blasting		35.000
Ladder		
Treated Timbers	$ 6,000	
Misc. Anchors	3,000	
Prefab. Metal Ladder	100,000	109,000
Rock Curtain		10.000
Services		
Surveying	$10,000	
Geotechnical	10,000	
Engineering/Inspection	30,000	50,000
Subtotal		324,000
Contingency (25%)		81,000
CAPITAL COSTS		$405.000
Annual 0 & M		$ 20,000
Upstream Facilities (Table 3)		
Capital Costs		$160,000
Annual 0 6 M		15,000
Subtotal		195,000
Total		
Capital Costs		$565,000
Annual 0 & M		$ 35,000

TABLE 2
Cost Estimate

Upstream Barrier

A.	Upper Falls - Fishway		
	Mobilization		$ 5.000
	Blasting		15,000
	Concrete - 30 yds3		30,000
	Ladder (Steep Pass) & Flume		10,000
	Services		
	Geotechnical	$ 3,000	
	Engineering/Inspection/Surveying	8,000	11.000
	Subtotal		$ 71,000
B.	Trestle Falls		
	Mobilization		$ 5,000
	Barrier Dams - 35 yd3		35,000
	Services		
	Engineering/Inspection/Surveying		15,000
	Subtotal		$ 55,000
C.	Other Upstream Barriers		$ 6.000
	Subtotal Upstream Barriers		$132,000
	Contingency		$ 28.000
	TOTAL		$160,000
	TOTAL 0 & M ANNUAL COSTS		$ 15,000

TABLE 3
HATCHERY OUTPLANTING

ESTIMATED COSTS

Summer Steelhead

0	Capital Cost: 50% of fish hauling truck	$30.000
0	Annual Operation and Maintenance: adult releases	$ 2.500/yr

Spring Chinook

0	Capital Cost: 50% of fish hauling truck	$30,000
0	Annual Operation and Maintenance:	
	rearing costs	$ 2,500
	fry releases	$ 2,500
		$ 5,000/yr

TABLE 4
PRELIMINARY COMPARATIVE COST ESTIMATE

TRAP AND HAUL

Mobilization			$ 20,000
Temporary Bypass			3.000
Barrier Dam			
Excavation		$15,000	
Concrete/Grating		25,000	
Cleanup/Backfilling/Riprap		10,000	
	Subtotal		50,000
Trap - Structural			
Fishway		$25.000	
Holding Pond & Grating		50.000	
	Subtotal		75.000
Trap - Mechanical/Electrical			
Electrical		$20,000	
Piping/Valves		20,000	
Automatic Crowders		20,000	
Pumps		5,000	
Truck		60,000	
	Subtotal		125,000
Services			
Geotechnical		$15,000	
Surveying		5,000	
Engineering/Inspection/Testing		25,000	
	Subtotal		45,000
Contingency (25%)			73.000
TOTAL CAPITAL COST			$391,000
Annual Operation and Maintenance Cost			
Facility		$15.000	
Truck 0 6 M		4.000	
Labor		12.000	
Vehicle Depreciation		8.000	
	Subtotal		8 39,000

APPENDIX A

PROJECT COST/BENEFIT ANALYSIS

ANALYSIS OF COSTS AND BENEFITS FOR
TRE OROFINO CREEK PASSAGE PROJECT

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BPA Project No. 87-112

October 1988

INTRODUCTION

Four options for producing anadromous salmonids in the drainage above Orofino Falls have been developed to the conceptual level of design. Three of the options (Alternatives 1, 2 and 3) involve enhancing adult fish passage at existing migration barriers and would allow development of a new, self-sustaining run of summer steelhead in Orofino Creek. Habitat conditions within the drainage are unfavorable for adult spring chinook, however, and would likely preclude a self-sustaining run of that stock despite passage enhancement. The fourth option (Alternative 4), which would involve no passage improvements, is a long-term program of annually seeding habitat above Orofino Falls with adult steelhead and juvenile spring chinook from a nearby fish hatchery. Such an outplanting program would allow spring chinook production within the drainage by avoiding significant habitat problems that adult chinook would experience during summer.

PROJECT COSTS

Cost estimates for Alternatives 1-4 were subjected to a present-value analysis to allow realistic cost comparisons between project options. The analysis assumed a discount rate of three percent, which is the “rate of time preference” used by BPA for power system analysis and project evaluations. For each alternative, the project life was set at 50 years.

Present-value costs for the four project options are given in Table 1. Total costs estimated for Alternatives 1, 2 and 3 vary by less than ten percent ($1,354,000 to $1,465,000). Alternative 4 (Hatchery Outplanting) would cost an estimated $240,000, considerably less than the other three options considered.

Table 1. Present-value[1] costs of four implementation alternatives for the Orofino Creek Passage Project.

Alternative	Item	Cost	Present-Value Cost
1. BARRIER MODIFICATION	capital cost	$ 439,000	$ 439,000
	fish stocking costs:		
	$2,000/yr @ Yr 1-5	10,000	
	$1,000/yr @ Yr 6-10	5,000	
	$400/yr @ Yr 11-15	2,000	
		17,000	14,500
	annual o/m ($35,000/yr)	1,750,000	900,500
	TOTAL COST		$1,354,000
2. TRAP-AND-HAUL	capital cost	$ 390,000	$ 390,000
	fish stocking costs:		
	$2,000/yr @ Yr 1-5	10,000	
	$1,000/yr @ Yr 6-10	5,000	
	$400/yr @ Yr 11-15	2,000	
		17,000	14,500
	annual o/m ($39,000/yr)	1,950,000	1,003,500
	TOTAL COST		$1,407,000
3. FULL LADDER	capital cost	$ 565,000	$ 565,000
	fish stocking costs:		
	$2,000/yr @ Yr 1-5	10,000	
	$1,000/yr @ Yr 6-10	5,000	
	$400/yr @ Yr 11-15	2,000	
		17,000	14,500
	annual o/m ($35,000/yr)	1,750,000	900,500
	TOTAL COST		$1,465,000
4. HATCHERY OUTPLANTING	capital cost (truck)	$ 60,000	$ 60,000
	annual o/m ($7,000/yr)	350,000	180,000
	TOTAL COST		$240,000

1 - Discount rate = 3%; project life = 50 years.

BENEFITS ANALYSIS

ALTERNATIVES 1, 2 AND 3

Benefits of enhancing adult fish passage within the Orofino Creek drainage will accrue when steelhead smolts produced in habitat upstream of Orofino Falls are caught as adults. Passage enhancement is not expected to benefit spring chinook salmon.

Potentially accessible habitat in the drainage above Orofino Falls has been estimated to be capable of producing a total of 13,846 steelhead smolts (Huntington 1988). Of this total, 13,561 smolts could be produced by habitat made accessible to steelhead solely through passage enhancement at Orofino Falls, Upper Falls and Trestle Falls. Passage would have to be improved at three additional migration barriers[1] to realize the remaining production potential of 285 smolts.

Future returns and harvests of adult summer steelhead to result from implementation of Alternative 1, 2 or 3 will depend on the potential for smolt production above Orofino Falls, survival rates for the stream's steelhead at various stages of their life cycle, and future harvest rates. Probable survival and harvest rates were selected assuming that the Orofino Creek steelhead run will be derived from B-run Clearwater River stock and that mainstem passage conditions in the Columbia and Snake rivers will be improved in the future per the goals of the Columbia River Basin Fish and Wildlife Program (Table 2). It is estimated that each wild fish which spawns in the drainage above Orofino Falls will contribute 54 smolts to the progeny year class of summer steelhead. Wild summer steelhead smolts from Orofino Creek are anticipated to return as adults to the Clearwater River at a rate of 2.41%.

A reasonable scenerio for development of the Orofino Creek steelhead run would involve annually passing enough surplus spawners from Dworshak National Fish Hatchery over Orofino Falls to fully seed available habitat until naturally

---

1 - Jaype Mill Dam at SK 4.7 on Quartz Cr., Duffy Dam at SK 1.3 on Canal Gulch, and a small log jam at SK 0.4 on Trapper Gulch.

Table 2. Sequential life stage parameters for a future wild stock of B-run summer steelhead in the Orofino Creek drainage, Idaho.

Life Staae Parameter	Relative Numbers of Wild Fish
1. escaping spawners	1
2. eggs per escaping spawner 1	3600
3. emergent fry (50% survival)	1800
4. smolts above Orofino Falls (3% survival 2)	54
5. smolts below Orofino Falls 3	54
6. adults returning to below Bonneville Dam (5.19% surviva1 4)	2.80
7. adults passing Bonneville Dam (95% survival)	2.66
8. adults harvested in Zone 6 set-net fishery (30% mortality 5)	0.80
9. adults escaping Zone 6 set-net fishery (70% survival)	1.86
10. adults passing The Dalles Dam (95% survival)	1.77
11. adults passing John Day Dam (95% survival)	1.68
12. adults passing McNary Dam (95% survival)	1.60
13. adults passing Ice Harbor Dam (95 surival)	1.52
14. adults passing Lower Monumental Dam (95% survival)	1.44
15. adults passing Little Goose Dam (95% survival)	1.37
16. adults passing Lower Granite Dam (95% survival)	1.30
17. adults available to spawn in Orofino Creek or to be harvested in a terminal fishery[6]	1.30

1 - 6,000 eggs/female, 3 females/2 males for B-run steelhead at Dworshak National Fish Hatchery (Howell & al. 1985)

2 - from Bjornn (1978)

3 - assumed no smolt mortality passing downstream over Orofino Falls

4 - USACE (1985) estimate for 1995 conditions, assuming major juvenile passage improvements at mainstem Columbia and Snake river dams as well as full transportation of smolts

5 - estimated Indian gill-net harvest in the Columbia River

6 - represents a 2.41% smolt-to-adult return to Clearwater River (1.30 adults per 54 smolts)

returning adult fish can do so. Future returns and harvests of steelhead under this scenerio were modeled assuming the following:

- o survival and harvest rates given in Table 2
- o adult hatchery steelhead passed over Orofino Falls would have the same same sex ratio anticipated for the developing Orofino Creek stock (3 females: 2 males)
- o only enough hatchery fish would be passed over Orofino Falls to ensure full seeding of available habitat
- o hatchery supplementation of the run would stop once naturally returning adults could fully seed available habitat
- o annual survival and harvest rates would be constant
- o each hatcheryxhatchery mating produces only 50% as many smolts and 25% as many returning adults as each wildxwild mating
- o adult steelhead which are one or more generations removed from the hatchery are wild fish
- o random spawning between hatchery and wild steelhead
- o full dispersal of adult and juvenile fish throughout accessible habitat
- o each hatcheryxwild mating produces only 75% as many smolts and 62.5% as many returning adults as each wildxwild mating
- o all adult B-run steelhead spawn as 5-year olds
- o adult steelhead are harvested by the Columbia River Zone 6 Indian set-net fishery at a constant annual rate of 30%

- o only steelhead in excess of the number of returning adults needed to fully seed habitat available above Orofino Falls may be harvested in a terminal fishery (this assumption would be consistent with a current catch-and-release fishery for wild steelhead in the Clearwater River downstream of Orofino Creek)

- o adult steelhead would first be passed over the falls in Project Year 1

- o a 50-year project life for each project alternative

Adult returns and harvests of Orofino Creek steelhead produced under the assumed run-building scenerio would be expected to first reach their full size after four adult return cycles (Table 3). Summer steelhead produced above Orofino Falls would be harvested in the Zone 6 net fishery and return to Orofino Creek for the first time five years after the initial release of hatchery spawners (Project Year 6). The need for hatchery supplementation of the run would end 15 years after the first release of hatchery spawners (in Project Year 16).

Assuming enhancement of adult fish passage only at Orofino Falls, Upper Falls and Trestle Falls, the Orofino Creek steelhead run would grow to support a Zone 6 harvest of 201 fish and return 327 potential spawners to the Clearwater River (Figure 1). Of the 327 fish returning to the Clearwater, 76 (23%) could be harvested without reducing smolt production above Orofino Falls. It would take an estimated 251 spawners to fully seed habitat available above the falls.

ALTERNATIVE 4

The proposed outplanting program would allow production of both summer steelhead and spring chinook smolts in the drainage above Orofino Falls without any enhancement of adult passage conditions. The returning runs of adult fish would not be self-sustaining and would always consist of the offspring of hatchery parents.

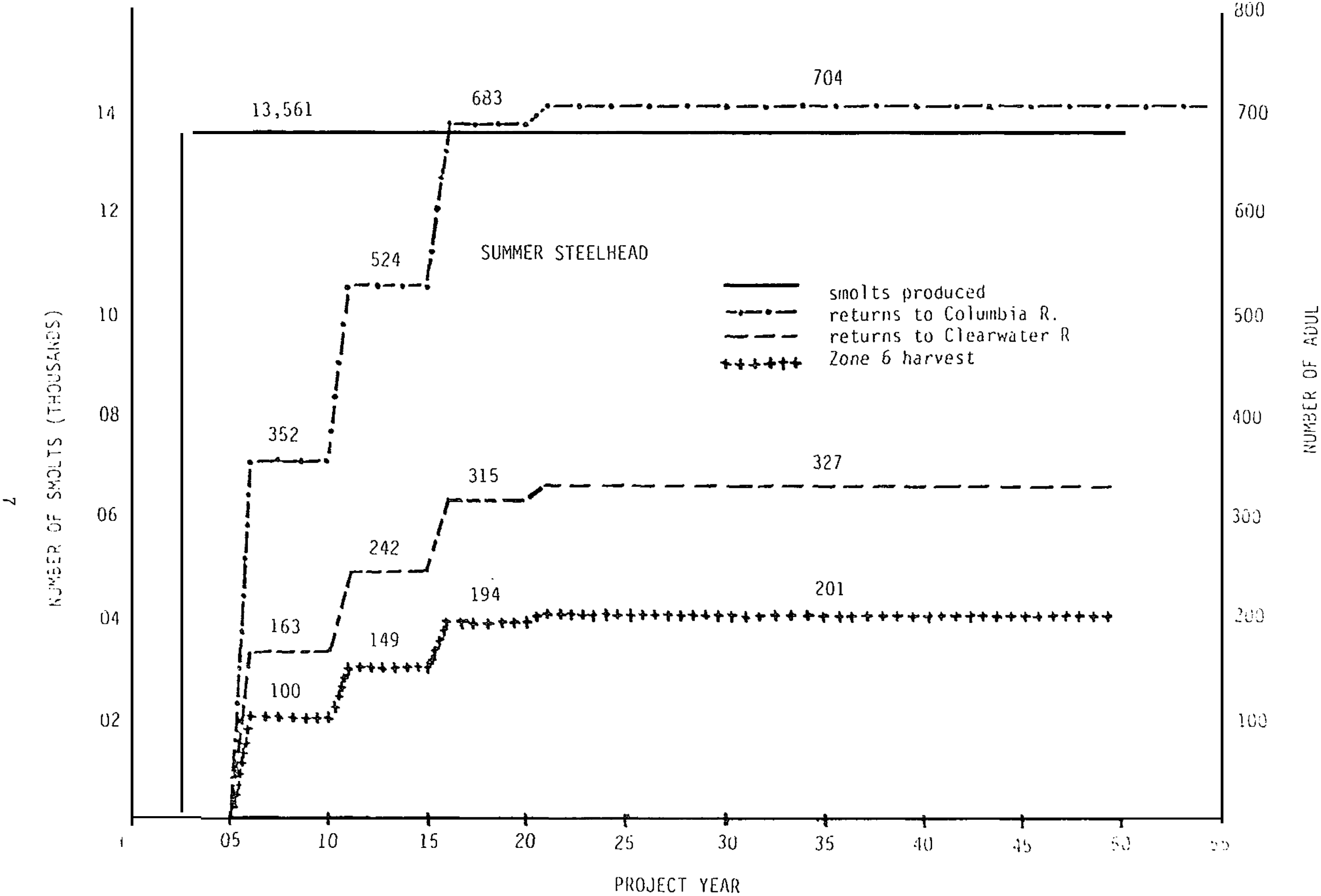

Figure 1. *Estimated smolt production and adult returns for Orofino Creek steelhead after* implementation of Alternative 1, 2 or 3. Steelhead numbers assume: 1) adult fish passage is provided only at Orofino Falls, Upper Falls and Trestle Falls; and 2) enough surplus spawners from Dworshak National Fish Hatchery are passed over Orofino Falls each year to fully seed available habitat until naturally returning fish can do so.

Table 3. Hatchery supplementation, harvests and returns of Orofino Creek steelhead under the run-building scenerio assumed for the Orofino Creek Passage Project. Figures outside parentheses represent adult numbers if fish passage is enhanced only at Orofino Falls, Upper Falls and Trestle Falls. Figures in parentheses represent adult numbers if passage is also enhanced at three key migration barriers above the Trestle Falls[1].

Category of Adult Steelhead	Adult Return Cycle				
	1 (year 1-5)	2 (year 6-10)	3 (year 11-15)	4 (year 16-20)	>4 (year >20)
adults harvested by Zone 6 fishery	0 (0)	100 (103)	149 (152)	194 (198)	201 (205)
adults returning to Clearwater R.	0 (0)	163 (167)	242 (247)	315 (322)	327 (333)
need for adult supplementation	502 (513)	148 (166)	18 (18)	0 (0)	0 (0)
surplus adults available for terminal harvest	0 (0)	0 (0)	0 (0)	64 (66)	76 (78)

1 - Jaype Mill Dam at SK 4.7 on Quartz Cr., Duffy Dam at SK 1.3 on Canal Gulch and a small log jam at SK 0.4 on Trapper Gulch.

Summer Steelhead

Fishery benefits to result from outplanting steelhead were estimated using the same life-cycle model and steelhead survival assumptions used to assess the probable benefits of Alternatives 1, 2 and 3. An additional assumption was that the program would ensure full utilization of rearing habitat upstream of Orofino Falls which could have been made accessible to adult steelhead through passage enhancement. Benefits of Alternative 4 will accrue when the offspring of adult hatchery steelhead released into the drainage above the falls return as adults to the Columbia River system and are subsequently caught in commercial and sport fisheries.

Figure 2 depicts steelhead smolt production, adult returns and harvest anticipated to result from implementation of Alternative 4. Annual production of 13,846 smolts would begin in Year 3, leading to an annual run of 359 Orofino Creek steelhead returning the the Columbia River system. Of this annual run, it is anticipated that 102 adults would be harvested in the Zone 6 net fishery and 166 would return to the Clearwater River. Adult steelhead returning to the Clearwater, or ultimately to the base of Orofino Falls, would be available for additional harvest.

Under Alternative 4, the Orofino Creek steelhead run would not be expected to build to the same numerical size as that anticipated for Alternatives 1, 2 and 3. This reflects the inability of a run entirely dependent upon hatchery outplanting to become better adapted to localized habitat conditions over time.

Spring Chinook

Benefits of the proposed 50-year program to outplant spring chinook fry were predicted assuming full and effective utilization of rearing habitat previously identified as suitable for spring chinook production. This habitat has been estimated to be capable of producing 36,349 spring chinook smolts (Huntington 1988). 15,264 of the smolts could be produced in Orofino Creek tributaries currently dominated by brook trout. However, several consecutive years of chinook outplanting would be required before smolt production in these tributaries would reach the projected level. For this analysis, was assumed

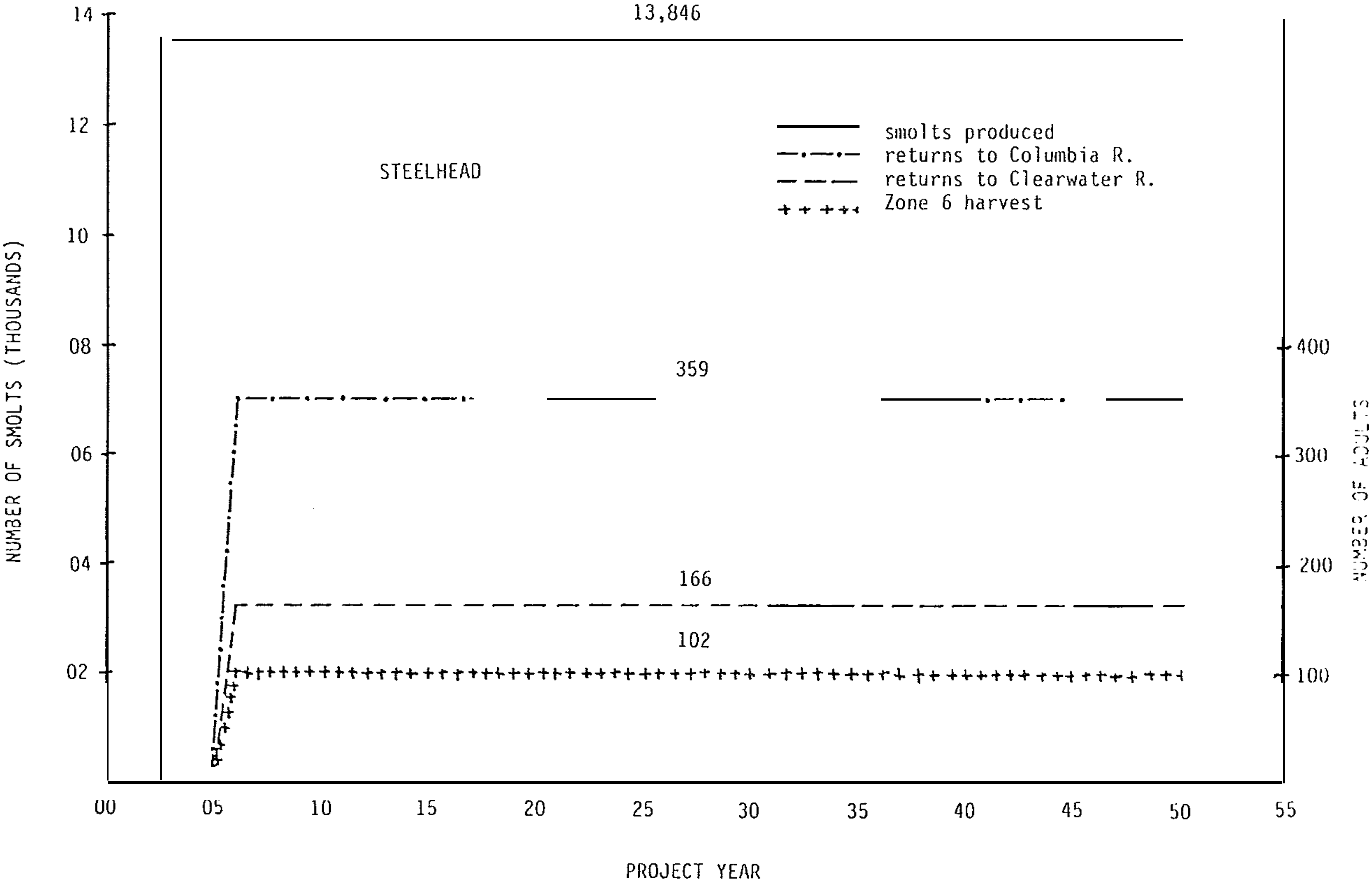

Figure 2. Estimated smolt production and adult returns for Orofino Creek steelhead after implementation of Alternative 4 (hatchery outplanting). Steelhead numbers assume full utilization of rearing habitat which could have been made accessible to adult fish through passage enhancement.

that annual smolt production in tributaries dominated by brook trout will increase linearly to reach full potential after four years of hatchery outplanting.

The rate at which spring chinook smolts produced in the Orofino Creek drainage will return to freshwater as adults is uncertain. No data are available on recent smolt-to-adult return rates for hatchery chinook fry planted in Idaho streams. Aowever, it seems reasonable to expect these fish, which will have been exposed to the selective pressures of a natural stream, to return as adults at a rate higher than those of hatchery smolts and lower than those of wild fish. Spring chinook smolts produced in hatcheries presently return as adults to Idaho at rates of about 0.1% and lower (B. Miller, USFWS, pers comm.). Wild spring chinook smolts are returning as adults to Idaho at higher rates, perhaps as high as 1% (Dr. T. C. Bjornn, Univ. Idaho, pers comm.). For lack of better information, an intermediate value of 0.5% was selected as a best approximation of the rate at which spring chinook smolts produced from hatchery fry released into the Orofino Creek drainage will return to Idaho as adults. The 0.5% rate is slightly higher than a 0.36% return rate IDFG (1985) set as a long-range goal for hatchery-reared spring chinook smolts.

Idaho spring chinook are generally thought to return to the Columbia River system at twice the rate at which they return to Idaho (IDFG 1985). The difference in return rates is related to incidental harvest in fisheries and losses of adult fish as they migrate upstream over dams and through reservoirs. In this analysis, it was assumed that spring chinook smolts produced in the Orofino Creek drainage will return as adults to the Columbia River system at a rate of 1.0%

Most Idaho spring chinook migrate seaward as l-year old smolts and return to freshwater as 4-year old adults (Howell & al. 1985). To simplify this analysis, it was assumed that all adult chinook will return to Orofino Creek as 4-year olds.

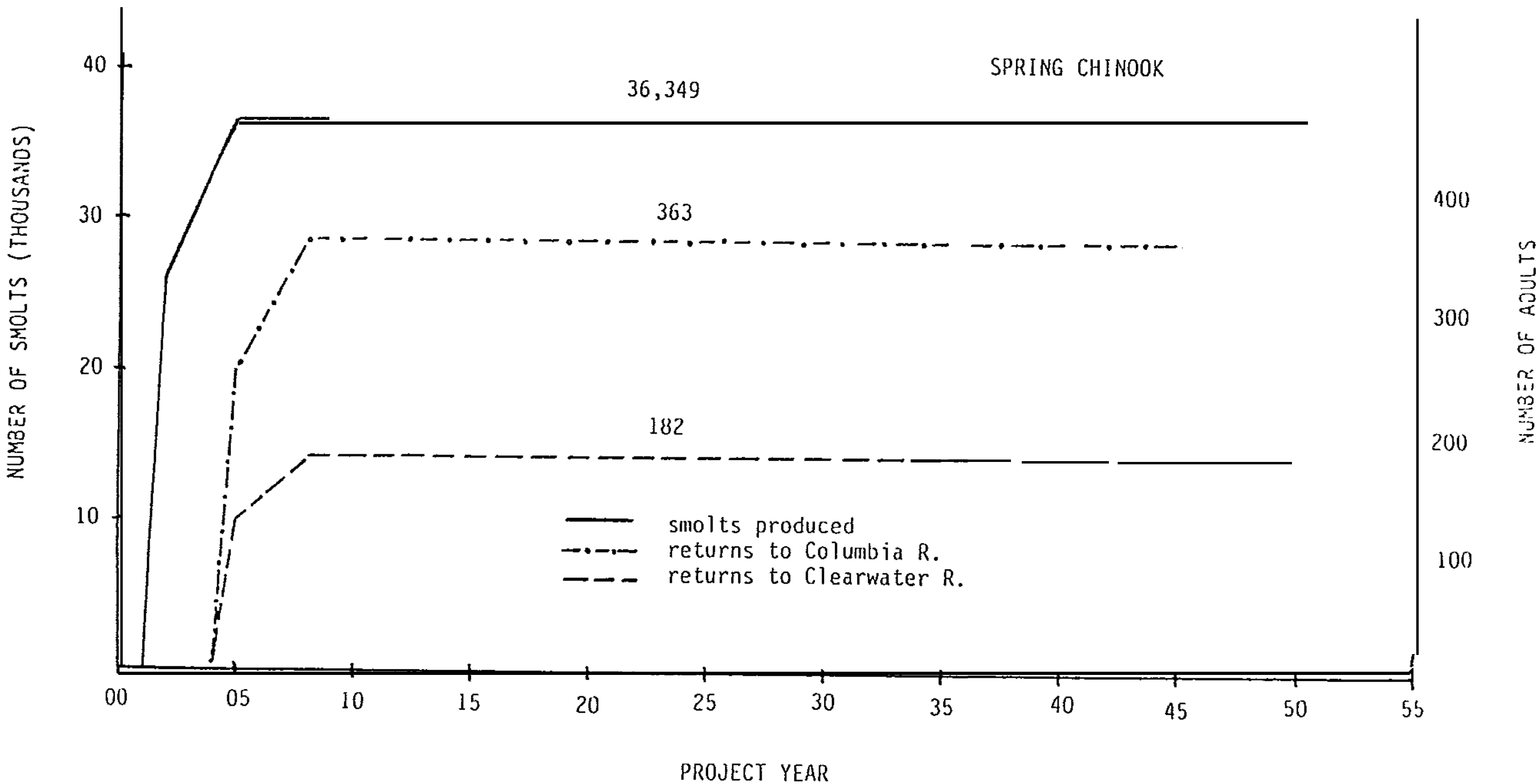

Figure 3. Estimated smolt production and adult returns to result from outplanting spring chinook fry from a nearby hatchery into the Orofino Creek drainage (Alternative 4).

Figure 3 depicts spring chinook smolt production and adult returns predicted to result from implementation of Alternative 4 if fry plants begin in Project Year 1. Annual smolt production would steadily increase from 24,901 fish in Year 2 to 36,349 in Year 5, then continue at 36,349 fish through Year 50. Returns of adult spring chinook would lag three years behind smolt production. Annual adult returns to the Columbia River would increase from an estimated 249 fish in Year 5 to 363 in Year 8, then continue at 363 fish through Year 50. Adult returns to the Clearwater River would be anticipated to begin at 125 fish in Year 5, grow to 182 by Year 8, then continue at 182 fish through Year 50.

COST-BENEFIT RELATIONSHIPS

The relative cost-effectiveness of project alternatives was evaluated by comparing estimated implementation costs to the numbers of anadromous salmonids each alternative would produce (Table 4). The cost of each alternative was expressed as the levelized (constant) annual payment necessary to repay a 50-year loan taken out to cover the entire project. A discount rate of 3 percent was assumed. Project benefits were expressed as the average number of smolts or adult fish each alternative would produce annually over a 50-year project life.

All four project alternatives will increase summer steelhead production in the Orofino Creek drainage. However, the cost incurred per steelhead smolt produced above Orofino Falls is anticipated to be about 15 times higher for Alternatives l-3 (passage enhancement) than for Alternative 4 (hatchery outplanting). The cost incurred per returning adult steelhead would be approximately 10 times higher for Alternatives 1-3 than for Alternative 4. Total cost per steelhead smolt produced, or per returning adult, is anticipated to differ by less than 10 percent among Alternatives 1, 2 and 3.

Table 4. Costs and fishery benefits of four implementation alternatives for the Orofino Creek Passage Project[a]. Alternatives 1-4 benefit steelhead, but only Alternative 4 benefits chinook.

	Alternative 1 (steelhead)	Alternative 2 (steelhead)	Alternative 3 (steelhead)	Alternative 4 (steelhead)	Alternative 4 (chinook)
Present-Value Cost	$1,354,000	$1,407,000	$1,465,500	$81,500	$158,500
Levelized Annual Cost	$52,624	$54,684	$56,957	$3,168	$6,160
Average Annual Smolt Production	12,747	12,747	12,747	13,015	35,154
Average Number of Adults Annually Returning to Columbia River	578	578	578	323	329
Average Number of Adults Annually Returning to Clearwater River	268	268	268	149	165
Average Number of Adults Annually Available for Harvest[b]	217[d]	217[d]	217[d]	241[d]	165[e]
Cost Per Smolt Produced[c]	$4.13	$4.29	$4.47	$0.24	$0.18
Cost Per Adult to Columbia R.[c]	$91.04	$94.61	$98.54	$9.81	$18.72
Cost Per Harvestable Adult[c]	$242.51	$252.00	$262.47	$13.15	$37.33

a - Analysis assumes a 50-year project life and 3 percent discount rate.

b - Adult fish which would be harvested in existing fisheries or which could be harvested without reducing the natural production of smolts in the Orofino Creek drainage.

c - (levelized annual cost)/(average annual number of fish produced).

d - Zone 6 harvest plus Clearwater River escapement in excess of escapement needs.

e - Number of adults returning to the Clearwater River.

Although Alternative 4 would be expected to produce more steelhead per invested dollar than would Alternatives l-3, the steelhead it produced would always be the direct offspring of hatchery fish. As such, these steelhead would only represent increased Idaho fish production if existing rearing facilities and suitable outplanting sites other than those in the Orofino Creek drainage were well-seeded with juvenile fish. In contrast, Alternatives l-3 would lead to the development of a new, self-sustaining run of steelhead. Such a run would add to the existing production of anadromous salmonids in Idaho.

Of the four project options considered, only Alternative 4 would lead to the production of spring chinook salmon in Orofino Creek. Alternative 4 would produce spring chinook smolts more economically than it would produce steelhead smolts.

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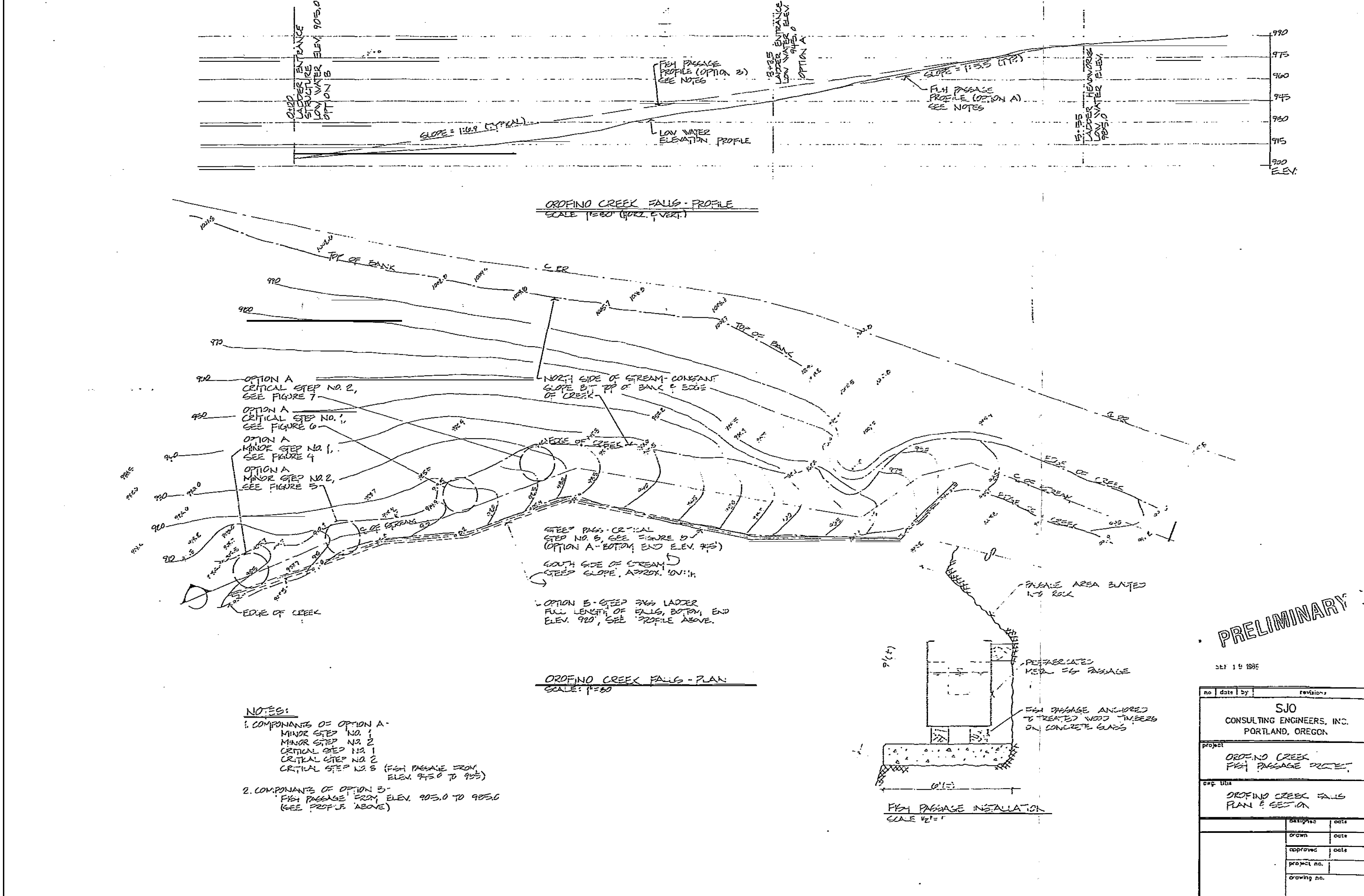
APPENDIX B

OROFINO CREEK FALLS - PLAN & SECTION DRAWING



0+00 LADDER ENTRANCE STRUCTURE LOW WATER ELEV. 905.0 OPTION B
FISH PASSAGE PROFILE (OPTION B) SEE NOTES
3+35 LADDER ENTRANCE LOW WATER ELEV. 945.0 OPTION A
SLOPE = 1:3.5 (TYP.)
FISH PASSAGE PROFILE (OPTION A) SEE NOTES
5+35 LADDER HEADWORKS LOW WATER ELEV. 985.0
SLOPE = 1:6.9 (TYPICAL)
LOW WATER ELEVATION PROFILE
990
975
960
945
930
915
900
ELEV.
OROFINO CREEK FALLS - PROFILE
SCALE 1"=30' (HORZ. & VERT.)
TOP OF BANK
C ER
OPTION A CRITICAL STEP NO. 2, SEE FIGURE 7
OPTION A CRITICAL STEP NO. 1, SEE FIGURE 6
OPTION A MINOR STEP NO. 1, SEE FIGURE 4
OPTION A MINOR STEP NO. 2, SEE FIGURE 5
NORTH SIDE OF STREAM - CONSTANT SLOPE B/T TOP OF BANK & EDGE OF CREEK
EDGE OF CREEK
C OF STREAM
STEEP PASS - CRITICAL STEP NO. 3, SEE FIGURE 8 (OPTION A - BOTTOM END ELEV. 945)
SOUTH SIDE OF STREAM STEEP SLOPE, APPROX. 10V:1H
OPTION B - STEEP PASS LADDER FULL LENGTH OF FALLS, BOTTOM END ELEV. 920', SEE PROFILE ABOVE.
PASSAGE AREA BLASTED INTO ROCK
PREFABRICATED METAL FISH PASSAGE
FISH PASSAGE ANCHORED TO TREATED WOOD TIMBERS ON CONCRETE SLABS
6'(±)
FISH PASSAGE INSTALLATION
SCALE 1/2"=1'
PRELIMINARY
SEP 19 1985
OROFINO CREEK FALLS - PLAN
SCALE: 1"=30'
NOTES:
1. COMPONANTS OF OPTION A -
MINOR STEP NO. 1
MINOR STEP NO. 2
CRITICAL STEP NO. 1
CRITICAL STEP NO. 2
CRITICAL STEP NO. 3 (FISH PASSAGE FROM ELEV. 945.0 TO 985)
2. COMPONANTS OF OPTION B -
FISH PASSAGE FROM ELEV. 905.0 TO 985.0
(SEE PROFILE ABOVE)
no | date | by | revisions
SJO
CONSULTING ENGINEERS, INC.
PORTLAND, OREGON
project
OROFINO CREEK FISH PASSAGE PROJECT
dwg. title
OROFINO CREEK FALLS PLAN & SECTION
designed | date
drawn | date
approved | date
project no.
drawing no.